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ABSTRACT

Issues facing a college or university that seeks to change its telephone system are raised in seven chapters. Major topics addressed by this resource guide are: telephone deregulation and changes in the telephone industry, the new technology available, how to manage a system, consultants, financing options, and institutional case studies. Specific areas of concern include: factors to consider when changing a system; management and cost controls; why and when to choose a consultant; financing for public and private colleges, and external funding. Technological concerns include: Private Branch Exchanges (PBX), analog transition vs. digital, PBX switching, PBX link to databases and computing facilities, PBX internal links, ancillary services, and PBX access to local area networks. Chapter titles and authors are as follows: "The Changing Telecommunications Environment" (Michael A. Toner); "Managing Change" (M. Toner); "Selecting a Consultant" (David C. Metz); "Financing a New Telephone System" (William B. Dougherty, John W. Sleasman); "Telephone System Technology" (John M. Urban); "Large-Institution Case Study: University of Tennessee, Knoxville" (Homer S. Fisher); and "Small-Institution Case Study: McPherson College" (James M. Dodson). A 240-item glossary is included. (SW)

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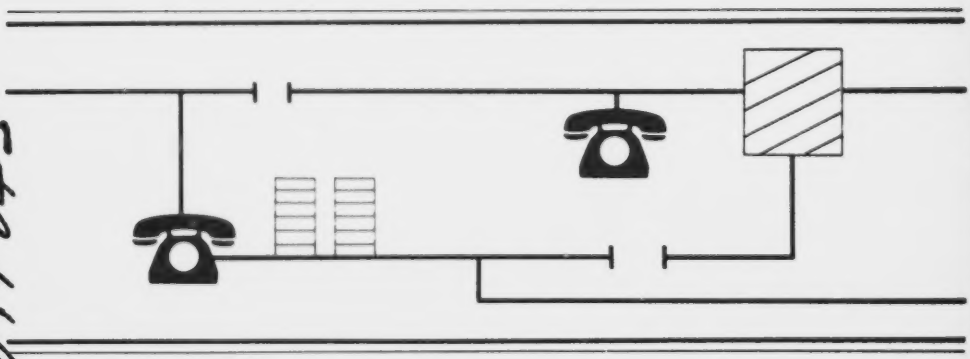
CAMPUS TELEPHONE SYSTEMS

MANAGING CHANGE



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Preface

Recognizing the great concern at institutions of higher education regarding the future of campus telephone systems, NACUBO's 1983-84 Facilities Planning and Management Committee approved and sent to the Board of Directors a proposal for a book that would give administrators an overview of a rapidly changing field. The proposal was approved, resulting in this volume.

The book is not intended to provide in-depth answers but rather to stimulate questions and illuminate some of the issues raised when an institution determines that changes in its telephone system may be necessary. Throughout, the project had the support of the Association of College and University Telecommunications Administrators (ACUTA), and that support is greatly appreciated.

It is important to note that the divestiture of AT&T in January 1984 brought dramatic change. AT&T and the regional Bell operating companies moved into the competitive environment with new products, services, and payment plans. Changes in the industry have created a number of options to be considered by institutions currently exploring ways of acquiring telephone services. It is not the purpose of this book to detail all such options—institutions must proceed in the knowledge that much in telecommunications becomes obsolete overnight. This volume can serve only to encourage administrators to make further and more comprehensive explorations.

The chapters were written by different authors, who come from various backgrounds and have a broad range of experience. The authors are listed below.

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NACUBO particularly thanks Michael A. Toner, who from the beginning offered invaluable advice and support in an unfailingly amiable manner. Other contributions were made by Mark B. Carrig, formerly of Villanova University; Judy Di Mattia, Fairleigh Dickinson University, and formerly of New York University; Larry L. Larson, University of New Mexico; and Ruth A. Michalecki, University of Nebraska-Lincoln.

The 1983-84 Facilities Planning and Management Committee was composed of the following members (they were at the institutions cited below during the 1983-84 year):

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Each chapter was extensively reviewed by persons knowledgeable in the field, including members of the NACUBO Editorial Board and other business officers, and telecommunications administrators and consultants. Those who contributed as reviewers are as follows:

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The Changing Telecommunications Environment

Prior to the AT&T divestiture in 1984, Bell's market research revealed a potential annual communications market of $300 billion. Up to that time the overall market had basically been controlled by the Bell System. The educational market represented about $500 million of the $300 billion total.

A recent cost study conducted by the International Communications Association (ICA) revealed that colleges and universities currently spend about 1.27 percent of their operating budget on telecommunications. When conducted in 1980, the same survey indicated that colleges and universities were spending 1.20 percent. This is a significant increase in a relatively short period of time.

The increase represents normal telecommunications growth in a market that until 1984 had been predominantly rental. In the coming years, as institutions purchase their telecommunications equipment, these cost figures will be even more visible in the total university budget.

Deregulation has opened up many previously unavailable opportunities for all users of telecommunications. Suddenly there are abundant choices in equipment (from switches to telephone instruments and every piece of hardware in between), in long distance services, and in telecommunications management information systems. To take advan-

tage of these new opportunities, the telecommunications manager must become thoroughly educated in all aspects of telecommunications and familiar with the many suppliers of these services and equipment.

Vendors will approach their potential customers with different philosophies. Some will offer whatever is fashionable at the moment; some will specialize as long distance common carriers, modem and terminal manufacturers, or telephone instrument manufacturers, for example.

Other vendors will operate according to long-term strategy. These will be the big companies, such as IBM, InteCom, ROLM, Northern Telecom, Mitel, and AT&T, with a lot of capital and the ability to shape the future of communications and control the largest share of the market. Fierce competition among these giants to gain market share will spur rapid advances in technology.

Those telecommunications managers in a position to take advantage of the technology and of the cost savings resulting from competition will be the big winners. Those who do nothing run the risk of paying high rental rates, being left with outdated and technically inferior equipment, and being bypassed as the cost savings window begins to close.

AT&T: A Brief History

On January 1, 1984, the long-awaited divestiture of American Telephone and Telegraph and the simultaneous deregulation of the telephone industry became reality. To better understand and appreciate the ramifications of these momentous events in terms of the campus, it is necessary to review the history of AT&T.

Alexander Graham Bell was credited with inventing the telephone on March 10, 1876. Two businessmen, Gardiner Hubbard and Thomas Sanders, who had been financing Bell's experiments, became his partners shortly after the momentous event. One year later in May 1877, Hubbard and Sanders devised the formula that would become the basic philosophy of the Bell System for the next 107 years: "Equipment could only be leased, not bought." In July 1877, the first Bell Company was organized and promptly offered for sale to Western Union for $100,000. Western Union, viewing the telephone as only a fleeting fad, declined the offer. In future years that decision would be regretted many times over.

Early in 1878 one of Western Union's biggest customers replaced its

telegraph equipment with the Bell Company's telephones. Western Union promptly offered to purchase Bell for $1,000,000. When the offer was refused by the Bell Company, Western Union decided to drive Bell out of business by purchasing the rights to telephone equipment manufactured by Elisha Gray and A.E. Dolbear. This resulted in the formation by Western Union of the American Speaking Telephone Company and the start of what became known as the "Telephone War."

Aware of Western Union's intentions and wishing to prepare for the legal battles ahead, the Bell Company hired Theodore Vail, an experienced professional manager, to run the organization.

From the very beginning, litigation became a way of corporate life for the Bell Company. Important legal battles with Elisha Gray over patent rights to the original telephone led to an 1879 Supreme Court decision that brought the Telephone War to an end:

1. The Court determined that Bell, not Gray, was the inventor of the telephone.
2. Western Union was ordered to sell all of its telephone interests in return for 20 percent of the Bell Company's profits over the next five years.
3. Bell was ordered out of the telegraph business and could not compete in any area being served by Western Union.

It was also in 1879 that Bell changed its name to the National Bell Telephone Company. More importantly, Bell bought control of Western Electric. In doing so the company made a unique business arrangement that would continue for over 100 years: Bell would buy all the equipment made by Western Electric and in return Western Electric agreed to sell all its equipment to Bell at cost.

"One System, One Policy, Universal Service"

In 1880 the company name changed again, this time to the American Bell Telephone Company. Through Vail's efforts, Bell began a program of buying up all the franchises it had once sold to eager takers.

Vail envisioned "one system, one policy, universal service" (detractors interpreted this as "maximum control for maximum profit"). Bell was now well on its way to becoming the largest corporation in the country. The basic framework was maintained up to divestiture in 1984—vertically integrated supply, a network of licensees substantially owned by AT&T, heavy emphasis on research and development, and strong supervision of the entire system by the parent corporation.

The year 1887 was significant in that Theodore Vail resigned be-

cause of philosophical differences with the company's financiers. Unlike the other directors of the company, Vail was an organizational genius with uncanny foresight. He was more interested in public service and long-term gains than immediate financial opportunity. During the next 20 years without Vail, the company continued to grow, but in a haphazard way.

In 1897 Bell was again reorganized, becoming the American Telephone and Telegraph Company. Up to this time in the company's history, Bell had been involved in over 600 lawsuits and had won them all.

In Vail's absence, however, Bell suffered from relatively poor management. In 1907 Vail returned to the company, reorganizing and revitalizing its management over a span of 10 years. During this period the growth pattern for the communications giant was set. Eventually, the Bell Company would evolve into an organization with five basic components:

- American Telephone and Telegraph
- The 22 operating companies
- Western Electric
- Bell Laboratories
- AT&T Long Lines

From the beginning all the way to divestiture, AT&T applied standardization, deciding for every operating company in the entire Bell System what financial policies would be adopted, what services would be instituted, and what practices would be followed.

Toward Monopoly

By 1913 AT&T had secretly gained controlling stock in Western Union. And the Bell System was refusing to connect independent companies to its long distance network. Responding to protests from a group of independent companies, the Department of Justice advised AT&T that certain planned acquisitions of independent companies were clearly in violation of the Sherman Antitrust Act. At the same time, the Interstate Commerce Commission began an investigation to determine whether AT&T was attempting to monopolize communications in the United States. Public sentiment was that Bell was too big and powerful, and forces were gathering to change this.

Bell could see the pressure quickly mounting. Vail decided to compromise and thus to put the company's affairs beyond criticism, if possible. Bell agreed to do the following:

1. Dispose of all its Western Union stock.
2. Acquire no more independent telephone companies without the approval of the Interstate Commerce Commission.
3. Allow other telephone companies to attach to the Bell System toll network.

This crafty bit of plea bargaining became known as the Kingsbury Commitment of 1913.

Further Investigations

The Communications Act of 1934 created the Federal Communications Commission, which replaced the Interstate Commerce Commission as the federal agency with jurisdiction over the nation's telephones. Thus began the first of four earnest investigations by the government into the corporate affairs of the Bell System. The major objective at this time was to separate Bell and Western Electric, but the attempt failed. In 1949 the government began a two-year, in-depth study of the Bell-Western Electric relationship; at the end of the study the government stated publicly that no evidence of wrongdoing had been found.

In 1956 Congress investigated the Bell-Western Electric arrangement and ruled that Bell had the right to decide who should receive licenses on AT&T patents. In addition, Congress ruled that non-Bell suppliers did not have the right to buy equipment from Western Electric unless the Bell System permitted them to do so. Bell was now free to set its own pricing policies.

Until 1968 the Kingsbury Commitment and the Communications Act of 1934 upheld the principle that the public interest was better served by a system of regulated telephone monopoly than by open competition. Up to this time tariff regulations flatly stated that use of any non-Bell equipment was essentially illegal and was cause for Bell to deny service. Thomas Carter and his famous Carterfone came along to challenge this policy.

Challenge to Monopoly

In the mid-1960s Carter invented a small device that permitted a trucker to interconnect a private two-way radio with the telephone system via a base station. Bell claimed this was illegal, but the FCC thought otherwise and in June 1968 ruled that the device could be connected to the telephone lines without threat of disconnection by Bell. Reluctantly, Bell agreed that foreign equipment could be attached

to its network as long as the equipment was technically compatible and protective devices were installed between the equipment and the phone company lines to safeguard the network.

Bell realized three distinct advantages from the requirement that protective devices be installed:

1. The devices could be rented only from Bell.
2. The arrangement seemed to imply that non-Bell equipment was not safe.
3. Bell could catch up technically with manufacturers of competing equipment by taking a long time to make the devices available.

MCI

The Carterfone decision of 1968 was only the beginning; other bars to competition began to fall. William McGowan, president of MCI, realized in the mid-1960s that one could transmit long distance calls via microwave at far less cost than the Bell System was charging to transmit the traditional way with coaxial cable. Determined to prove his theory, he brought a small microwave company and began transmitting toll calls between Chicago and St. Louis. This was the first attempt to compete with Bell in the long distance market in over 60 years.

When McGowan asked the FCC to approve service on this route, Bell's security was threatened. Up to this point there had been no competition in the long distance market because no company wished to begin rewiring the entire country.

But microwave technology changed all that. Bell immediately saw the danger in the successful use of microwave transmission by competitors and asked the FCC to freeze MCI out completely. This attempt failed and in 1971 the FCC's "specialized common carrier" decision ruled that anyone could offer long distance service.

With this momentous decision in hand, McGowan quickly set out to raise about $110 million in venture capital, which was used to build microwave circuits and transmitters and establish toll routes. As the number of subscribers increased and revenue began coming in, funds were reinvested in the company, and by 1975 a coast-to-coast network had been established.

However, a major problem remained for MCI: connecting customers to the MCI network. In the beginning customers were connected directly to MCI's long distance network, through separate facilities, but

this was inefficient and limited the customer base. The only practical way was to connect customers to the network via the local telephone exchange, thus allowing customers to use their regular telephones. This was far more convenient and meant all sorts of opportunities and increased revenues for MCI. And this did not escape the attention of Bell.

Upon learning in 1971 of the FCC's "specialized common carrier" decision, Bell, as usual, took the bad news gracefully, then initiated a program to do everything it possibly could to create difficulties for MCI. From the very beginning in 1971, under FCC pressure, Bell reluctantly provided MCI with some limited connections through the local exchanges. However, it was also at this time that Bell initiated a strategy to run MCI through a series of mazes.

Bell's strategy was simple: to stop interconnection to the long distance network by MCI and other common carriers by using legal, technical, and financial means. The longer MCI could be made to run around in circles, constantly being denied access to customers, the longer MCI was denied income. This in turn would force MCI to live off its own capital and to slow its construction and marketing plans. Eventually, Bell hoped, MCI would wither and die and the toll market would return to "normal."

All this adversity prompted MCI in 1975 to file an antitrust suit charging Bell with many anti-competitive practices such as:

1. Secretly planning to bypass the FCC and file toll tariffs with all 50 state public service commissions.
2. Testing the FCC's jurisdiction in court at one point by totally cutting off service to the entire MCI network.
3. Routinely providing MCI with two-wire circuits instead of four-wire circuits, resulting in inferior voice transmission.
4. Forcing MCI customers to use a 12-digit access code.
5. Denying access to Bell System operators, thus preventing MCI from offering person-to-person service to customers.
6. Attempting to reduce rates in selected areas to overcome any price advantage MCI might have.
7. Refusing to provide interconnection to FX or CCSA services.
8. Taking much longer to provide facilities to MCI than to AT&T Long Lines.
9. Imposing restrictions when facilities were provided to MCI.
10. Maintaining internal policies that threatened to remove any account manager or account executive if facilities were provided to any other carrier.

In 1980 MCI won a record antitrust judgment against Bell. The jury awarded triple damages—$1.8 billion. However, AT&T immediately appealed, and the case continued in the courts for another five years. In 1985 the appeal finally came to a conclusion—a Chicago federal court jury awarded MCI a total of $113 million for Bell's anti-competitive behavior that had delayed and disrupted service for business customers in the 1970s.

By 1974, even with the handicap of the Carterfone decision, the Bell System supplied about 80 percent of the phone service in the U.S. The Justice Department still felt this was too large a share and on November 20, 1974, filed a suit to attempt again to sever the Bell-Western Electric relationship. The suit was aimed not only at AT&T's size or market share but also at its behavior.

The most lucrative aspect of the old Bell System was its relationship with Western Electric. By permitting the operating companies to buy equipment only from Western, AT&T had a pure monopoly. Most importantly, AT&T could shift its huge profits away from the regulated parts of the corporation and toward the nonregulated manufacturing arm. Research costs for developing and building the equipment could be added to the local and long distance rate base.

A lengthy Justice Department investigation begun in 1974 determined that Bell was using the captive relationships among its manufacturing, Long Lines, and local telephone division to quash competition. It was also determined that Bell's interference with competition in these areas was causing technological stagnation. The 1974 suit was aimed at severing Western Electric from the rest of Bell and forcing Long Lines to deal with the local companies on a more arms-length basis.

In 1981, after many delays and 18 months of hearings, the trial actually began. The case could have dragged on in the courts for years.

However, AT&T realized that, while it was fighting antitrust actions and divestiture in court, the data market and the telecommunications revolution were quickly passing the company by. As a regulated monopoly AT&T was prevented from entering the computer market where it wanted to compete freely.

Divestiture Agreement

On January 8, 1982, AT&T shocked the world by reaching a settlement with the Justice Department. Judge Harold Green carefully reviewed and modified the agreement and in August 1983 finally approved the divestiture agreement.

Under deregulation, AT&T will continue to provide most of the long distance service between states and will be handling about one-half of the toll calls within the states. The local Bell company will handle local service and the remainder of interstate toll calls. Interestingly enough, toll rates for AT&T will continue to be regulated by the FCC while AT&T's competitors will be encumbered with very little regulation.

Many industry analysts agree that basic telephone service was underpriced because costs were spread unevenly. In effect, it was the toll network that kept telephone costs down and within almost everyone's reach. In some cases, this amounted to 30 percent of the local company's total revenue. Without this toll subsidization, a fierce upward pressure will be exerted on local rates. In general this will mean that telephone subscribers can expect to pay higher prices for all aspects of local service, with billing based on the exact cost of providing the service.

The FCC proposed replacing the subsidies with an "access" charge, which would be paid by residential and business customers as well as by competing long distance companies such as AT&T and MCI. The proceeds from these fees would go to the local phone companies to compensate them for providing access to the long distance network. This particular aspect of deregulation has come under heavy fire from many quarters. After numerous delays the access charge schedule finally went into effect for businesses on May 25, 1984, and for residential users on June 1, 1985.

Implications of Divestiture

Centrex, as opposed to PBX, customers will definitely feel the financial burden of the access charge. PBX customers are billed for access charges only on their trunklines while Centrex is billed for each main line in service. This apparent inequity is constantly debated but has not yet been resolved. Since Centrex is the only product local telephone companies can sell post-divestiture, those companies have a clear interest in preserving this offering, at least for the immediate future. Many local telephone companies, in order to maintain their customer base, are simply filing tariffs with their respective public service commissions to have the access charge reduced or absorbed entirely.

Some customers, feeling that the rates for both access and toll are exorbitant, are building their own networks that completely bypass the traditional exchange facilities. These bypass networks are established by using microwave, fiber optics, satellites, radio, or cable TV

lines. When many large toll users bypass exchange facilities, they will leave a large amount of fixed exchange costs to be borne by the remaining users of the network. As the user base shrinks, the rates paid by the remaining users will go up so that an acceptable grade of service can be maintained. Bit by bit, bypass by bypass, the exodus of large users will make telephone service more expensive for the small user.

Today, because of deregulation and competition, the user actually dictates what he wants in a system. The market is driving technology. An obvious case in point is the number of different manufactured products being offered by the regional Bell operating companies. They are not staying with one manufacturer such as Western Electric, but are assembling a broad line of products to meet customers' needs. Having a choice has put the user in a unique position. In theory, competition encourages the development of new technology and services and often produces lower prices, one of the real advantages of deregulation.

In a regulated market, rates are based on the phone company's average cost of serving customers. In a competitive market, rates are based on what the traffic will bear above actual costs. As the basis of phone pricing changes from average to actual costs, the customers who seem assured of benefiting the most will be large users with heavy telecommunications traffic.

Computers and telephones are increasingly being merged, and new devices are revolutionizing business communications. Products now on the market transmit voice and data simultaneously and perform tasks in a fraction of the time once required by an entire staff and a room full of equipment.

The launching of Sputnik in 1957 inaugurated the era of global satellite communications and the information age. The technologies of the telephone, the television, and the computer have been merged, permitting interaction between people and computers throughout the world. It is this new integrated communication system that will fuel the information age like nothing before. This should be of concern to colleges and universities because added information stress will in many cases push existing telecommunications systems to the limit or beyond.

2

Managing Change

Any serious telecommunications manager must realize that the opportunities presented by divestiture and deregulation are only a small part of the total picture. Telecommunications management in the information age involves more than just telephones—it involves development of a particular attitude about information management, which is destined to become one of the most important industries for the remainder of the twentieth century. Society seems to have arrived at the point where available technologies can be used to reshape the way business is conducted and the way people live and work.

Management of Telecommunications

Telecommunications is probably the single most important and all-encompassing administrative service that an institution provides to its employees. A large, complex organization simply cannot function without it. In attempting to evaluate the existing campus telecommunications system, administrators should first determine how far telecommunications management on campus has evolved.

There are basically five stages in the development of telecommunications management:

Stage 1—No effective management

Stage 2—Cost management

Stage 3—Equipment and system management
Stage 4—Introduction of telecommunications management into long-range planning
Stage 5—Integration of telecommunications technology and administrative management philosophy

Stage 1

In the first stage, telephone service is available to serve only the basic telecommunications needs of the campus. Neither the administration nor the users pay much attention to the service provided. Responsibility for the service in this phase is generally given to a person who wears many hats and considers telephones a low-priority item. Only when a large bill appears or when something stops working does telecommunications draw serious attention.

Stage 2

In the second stage, responsibility for telecommunications is assigned in order to control costs. The designated person generally has little technical expertise but is actively learning. Moving from the first to the second stage is important because large amounts of money can be saved if someone is watching expenses. However, focusing only on saving money can cause efficiency to suffer.

Stage 3

In the third stage, the telecommunications department takes on more complex projects such as equipment replacement, switch enhancement, long distance networking, telemarketing programs, automated billing systems, and resale programs. Generally, during this stage the telecommunications staff begins to grow to meet the needs of the system's users. A telecommunications department provides three basic services to users:

1. Consulting and system design
2. Coordination of installation
3. Ongoing network management

A good consultant will be very knowledgeable in telecommunications and will have solutions to many telecommunications problems. Consulting consists of interviewing the user to determine his or her problems, needs, and requirements, understanding how the system is to be used, understanding any policies governing the user, knowing

any financial restrictions, writing installation orders or specifications for the new system, writing a request for proposal (RFP), evaluating responses to the proposal, and selecting the best system to meet all needs of the user. The user should not have to alter drastically his or her methods of operation to suit the system. The bottom line here is that the new system must provide better service than the service it replaced.

In this third stage of telecommunications management, the successful manager should do the following on a regular basis:

1. Develop an inventory of the system's physical assets. Exact size and cost must be identified, as must all primary vendors. While doing this, the manager will come to understand how the present system is being used and will be able to identify the system's current problems and limitations. The manager must then determine present and future voice and data communications requirements.

2. Identify all monthly costs, including equipment rental, local messages, regular toll, least-cost routing toll, and other charges and credits (OCC). It will also be helpful to identify costs by department, by type of service, and by individual vendor.

3. Check the system to identify needs. The manager must be familiar with the institution's communities of interest.

4. Evaluate the system, including equipment, cable facilities, and incoming trunks. The evaluation extends to alternative equipment and services and the number of personnel needed to run the department.

5. Design an optimum system to meet the institution's current and future needs. Careful forecasting will prevent purchase of a system that is too small and that will be outgrown before it has paid for itself.

6. Prepare implementation plans well in advance of cutting over to a new system. The telecommunications manager will need to develop policies and procedures for the ordering of equipment and service, for repair and maintenance, for billing, and for continuous training of all those involved in the system.

7. Develop a keen knowledge of local rates and tariffs, national regulatory trends, and all pending regulatory changes. In addition, the manager must be aware of new equipment and services.

8. Be willing to upgrade his or her knowledge in telecommunications. It will be necessary to subscribe to trade journals and to attend relevant seminars and workshops as part of ongoing training. Joining an association of telecommunications users is also a helpful way to keep up with developments in the field and to be involved in finding solutions to mutual problems.

Even with all these careful preparations and daily routines, management of the telephone system in the third stage still has a generally low profile in campus administration.

Stage 4

Only in the fourth stage does long-range campus telecommunications planning become important. First, the campus administration begins to include the telecommunications manager in planning sessions. Through the telecommunications manager, the administration gains a fuller technical appreciation of telecommunications and realizes the impact that new telecommunications technology can have on the entire organization. Bringing telephone, data, and word processing networks together can now be seen in the context of cost effectiveness. User planning committees should be formed to study telecommunications systems and make financial recommendations. The end user's needs in the design and selection of systems are now increasing in importance.

Stage 5

In the fifth stage, telecommunications management is integrated with university procedures. Here, technology is not reshaped to fit the needs of the university. Instead, a reshaping is required of both the technology and the institution's administrative philosophy to make best use of the technology available. Telecommunications management should be highly visible in the organization at this point and should be playing a very important part in developing long-range plans. Upper management will likely begin to recognize the overall importance of telecommunications management and the effect it can have on the accomplishment of the institution's mission.

Most institutions today have progressed only to stage 3, and a few to stage 4. In order to progress further, any telecommunications department will have to address four major problem areas:

1. Lack of clearly stated long-term goals and strategies. An effective strategy must outline just how telecommunications technology can be applied to the particular needs of the users at the institution.
2. Inability to measure how effectively telecommunications decisions mesh with the goals of the institution. A system of measurements must be developed to judge implemented projects on the basis of efficiency, cost savings, and cost effectiveness.

3. Lack of facilities to train and develop competent telecommunications personnel. A commitment must be obtained from the administration to recruit, train, and develop telecommunications personnel.

4. Inability to respond to the needs of system users. A mechanism must be in place to monitor constantly the needs of the users. Those needs must addressed in a constructive and creative way.

The telecommunications manager is in an excellent position to influence the direction of telecommunications and at the same time to enhance the value of the position within the organization. The successful manager should have:

1. A good working understanding of the technology involved in telecommunications, data, and word processing networks.

2. A working knowledge of how this technology can be applied to the problem of office productivity.

3. A vision and a plan for incorporating the different technologies into an architecture that meets the needs and requirements of all the users.

4. The management skill to promote and implement the program.

Changing the Telephone System

Deregulation has created opportunities that never existed before—higher education administrators can now shop around the marketplace for telephone equipment. Unfortunately, many of those responsible for telephone service at their institution are not technically qualified for the task. In many cases they have been thrown suddenly into the world of big telephone decisions and have not yet had time to become proficient in this new area.

Institutions choosing to make no changes in their telephone system run the risk of paying for services they no longer receive and for equipment that does not do a proper job. The shortcomings of existing equipment may prevent institutions from doing what other colleges and universities routinely do with their telephone switches. (At the very least, doing nothing may cause an institution to miss an opportunity to increase the efficiency of every user of the system and to achieve potentially lower costs.)

With deregulation only recently implemented, the competition in the marketplace is fierce. Every system bears looking into, if only to find out what services the institution is paying for every month. It may be that an old system can be replaced by a new one that will pay for itself within five years. It is important that each institution have up-to-

date information about its system. Five major areas must be taken into account when changes in a telephone system are being considered:

1. Cost
2. Management and control
3. Age and condition of present equipment and facilities
4. Competition in the marketplace
5. New technology

Cost

Doing absolutely nothing with an institutional telephone system will be shockingly expensive in the long run.

The University of Wisconsin-Madison (UW-M), for example, recently replaced a 30-year-old switchboard in a hotel facility on campus. Before purchasing the new system, UW-M was paying $1365 per month for the equipment, not including the trunks. The price for the new system was $38,000, completely installed. This represented a payback of just 2.8 years. Considering the length of time a telephone system will remain unchanged in a hotel environment (which generally will be much longer than the average five-to-seven-year life span of a normal telephone system), the amount that can be saved over the years is quite significant.

In 1982 the University of Wisconsin System replaced a telephone system at the Superior campus with an electronic switch. Excluding trunks, the annual rental had been $60,528. The new system was purchased for $280,552, representing a payback period of 4.6 years. However, the payback period was reduced to 2.8 years by (1) cutting the number of operators, thus saving $19,000 per year; (2) reducing the number of moves and changes, saving $5,000 yearly; (3) consolidating and reconfiguring various lines and trunks, producing annual savings of $12,900; and (4) improving call accounting, saving $2,400 annually.

In today's environment, with deregulation, frequent rate increases, endless switches and vendors to select from, and a reduction in traditional services from the local telephone company, all institutions must take the time to audit and evaluate their present system.

For many institutions cost is the most compelling reason for initiating a project like this. Telephone service in the future is not going to be any cheaper than it is today. The past decade has seen a series of rate increases drive the cost of providing telephone service on campus from a minor expense to a major concern.

Since the local telephone companies can be expected to continue to ask public service commissions for "reasonable" rates of return, there

is no reason to believe that rates will not continue to climb. Again, overall costs can be controlled by careful management aimed at improving the efficiency of the system.

Users of Centrex have found this service to be very expensive, especially given that every main line will be billed an access charge (in a PBX system, access charges are billed only on the trunk lines that feed the system). With Centrex, the access charge added to the high monthly line rental costs will make the service prohibitively expensive for many institutions.

Some Centrex users are finding that by questioning the rates and working with the telephone company they can get substantial rate reductions or can acquire system features at attractive prices. The telecommunications manager should become actively involved in a program to cut the costs of the institution's system and maintain the current level of service.

At the University of Wisconsin-Madison the per line cost of Centrex II had risen to $13.06 per month. Touch Tone and all additional electronic features were priced separately and were added to the basic line charge. The use of Touch Tone and electronic features was becoming quite common on this system, thus causing line costs in many cases to exceed $19. Administrators were becoming alarmed at the increased costs and began looking seriously at alternatives.

One alternative considered was to convince Wisconsin Bell to lower the rates. A series of very intense meetings with that company resulted in a Centrex III, and a "deluxe feature package tariff" was filed late in 1984. With this new Centrex III tariff in place, the line costs are now $12.75 each, including the electronic features and Touch Tone.

To control telecommunications costs, many other items must be investigated. For example, directory assistance charges are a major concern today. Many offices, such as registrar, admissions, purchasing, student financial aid, medical center, and athletic department, regularly need telephone numbers in distant cities. In the future, the habits of staff in those offices will have to change or budgets will have to be increased to cover the charges.

Like directory charges, the cost of local message units is dependent on usage. This is another potential source of cost savings that should be investigated: Are phones in places that invite the public to use them? Have the restrictions on the lines been reviewed lately? Are the calls that are made from these phones legitimate business calls? Incremental time and material charges for installation of service and equipment should also be monitored.

Institutions choosing new systems could realize cost savings by having all the installation and maintenance work done by institutional employees or by contracting out the more difficult aspects of that work. Basic moves and changes that require only computer input should always be done by the customer.

The expense of buying or renting the equipment is more than justified by the savings in time and order-writing charges alone on simple changes (the current cost of actually writing and processing a change order through traditional channels can be as high as $75).

Using the software capabilities of the telephone system and a terminal connecting to the switch, there are two ways for the customer to carry out telephone changes: with Cenpac machines or similar equipment for Centrex, and with customer administrative panels (CAP) for other PBX-type equipment.

Centrex customers can rent Cenpac from some Bell operating companies. For example, Wisconsin Bell is currently offering this service to the University of Wisconsin-Madison for $.20 per line per month (a monthly total of $2,700). On the surface this may seem expensive, but the monthly installation costs for this institution were running between $4,000 and $5,000. By using Cenpac the campus is now saving more than $1,300 per month.

An additional benefit of a service such as Cenpac is that the customer is able to see the features and treatments on each line. This information enables the customer to make changes—both installations (moves and changes) and repairs.

Other advantages of the customer doing the work are better control of due dates and reduction of the overall cost of providing better service to all users of the system.

The accumulated long distance charge is the second largest part of the monthly telephone bill. The development of the local access transport areas (LATAs) has created many cost problems for institutions with a large volume of long distance calls.

These increased costs come in several forms. With the LATA structure, administrative costs have risen. In the past a customer received only one bill for toll service. Now many customers get as many as three bills: "interlata," "intralata," and some other common carrier (e.g., MCI or Sprint). The time required to administer these bills can be staggering. Not only are the assembly and distribution of the bills more complex now, but service and price comparison and network optimization are considerably more time-consuming.

The second problem is the increased cost of service itself. In many

cases a call from point A to point B did not change substantially at all after deregulation if it was within the same LATA. However, if that call crossed the newly formed LATA, the costs did increase. In Wisconsin this increase is roughly 8 percent for an "interlata" call. For a large institution this can amount to a considerable sum of money.

Even if an institution does nothing else with its entire telephone system, immediate attention must be given to long distance charges. Low-cost routing capabilities should definitely be part of any new system under consideration. Today there are many choices of carriers for a long distance network. A properly constructed and managed network can save thousands of dollars each month.

There is no question that an institution owning its own system will save money in the long run (renting a system in nearly all cases is more costly). A rough financial analysis on almost any new system will show a payback period of five to seven years or less, even with maintenance included in the overall cost. As part of any analysis, the telecommunications manager should solicit proposals, carefully evaluate the responses, and work with the figures.

In order to keep their customers, many local Bell operating companies are working with their major accounts with more enthusiasm than ever before. Now that the operating companies no longer have to purchase all their telephone equipment from Western Electric, they have on occasion, for example, offered to buy a switch of the customer's choice, install it, and maintain it at extremely attractive rates.

Bid proposals for a new telephone system will generally show a per line cost ranging from $600 to $1,000. A recent bid at one University of Wisconsin campus showed costs ranging from $446 to $988 per line installed.

Yale University has accepted a proposal by SONECOR (their local operating company's subsidiary) to install and maintain a NEAX 2400. The installation cost per line is about $588, with a monthly maintenance charge of $3 per line.

Management and Control

Because of deregulation many of the traditional services that the telephone company provided in the past will be unavailable and managers will be expected to handle the system themselves.

Managing a system in-house has distinct advantages: it saves money, permits total control over the entire system, and produces the exact results desired.

In the future there is no question that telecommunications administrators will have to become more self-sufficient. As billing, record keeping, traffic statistics, equipment inventory control, and other management functions begin to migrate from the phone company to the campus telecommunications office, there will be a growing need to use management information systems in the cost-control and decision-making processes.

This will be a critical area in telecommunications management and will have to be administered carefully or trouble will soon arise. Either developed in-house or purchased, software systems required for a successful campus telecommunications department include operational programs for at least the following basics:

1. Automated inventory control for wiring, cable, voice and data services, and equipment.
2. Automated work-order processing and tracking with statistical information available on demand.
3. Cost accounting and financial analysis that will provide the administration with meaningful information for cost-control purposes.
4. Billing reconciliation and charge-back capabilities.
5. Network engineering capabilities that will provide call-pattern and line-utilization reports. (For maximum benefit to the network, it will be necessary to translate this information into usable form and to create simulation models.)
6. Directory assistance for on-line assistance, updating, and publishing.

Age and Condition of Present Equipment and Facilities

On many campuses the existing telephone service is outdated. It may be lacking features in common use in most modern systems and may not be providing the service required by users on campus.

If the system is operating at, or almost at, capacity, blocking may be a common occurrence, causing users to have to wait for a dial tone. Doing nothing about this only prolongs a bad situation.

When reviewing the campus telephone equipment, managers must determine the quality of service provided compared to what it costs and whether AT&T Information Systems (ATTIS) will continue to support that equipment. An institution being served by a very old PBX should understand that ATTIS will likely soon attempt either to sell that equipment to the institution or urge the institution to install a

modern electronic PBX. Inevitably, many institutions will have to make a major switch decision.

Telephone service has been in existence on many campuses for over 100 years. The conduits that feed the buildings are often so full of cable that it is impossible to add more facilities. An institution in this situation and contemplating the addition of conduits to upgrade present cable facilities may be better off with a total revision of the system. However, even though it is difficult to pull out old unusued cable because the cables become wrapped around each other, it may be less expensive in the long run to do so, reusing the existing conduits by pulling out all the cables and replacing them with new cable, fiber optics, and coaxial cable.

Competition in the Marketplace

Deregulation has been a great benefit to telephone equipment vendors. Now that customers can use any equipment they choose, vendors are all trying to develop large customer bases. This particular kind of competition is not going to last forever and within a few years the weaker firms will fall away.

Because of the competition between manufacturers and vendors, the price of switches is dropping sharply. This is a great opportunity for the prepared telecommunications manager: for most applications he or she will have in excess of ten major manufacturers and an endless number of vendors from which to choose. And all prices are easily negotiable. Managers should carefully examine any overall system being offered, its specific application, and the price, size, maintenance requirements, reliability, and serviceability of the switch. For the first time the customer can actually get what he or she wants and does not have to take the only system offered.

A knowledgeable telecommunications manager will tell vendors exactly what he or she needs, and as a result should be able to find a range of bargains.

At an April 1983 seminar sponsored by the Association of College and University Telecommunications Administrators (ACUTA), Phillip W. Beidelman, president of Western Telecommunications Consulting, Inc., suggested the following strategies for managers considering purchase of a new system:

1. Be conservative in the economic analysis.
2. Do not oversell to institutional management.

3. Beware of too many vendors being involved in a single system.
4. Understand the power structures at the institution. Get to know the influence makers and make sure they are sympathetic.
5. Think through what vendors claim.
6. Do not buy on price alone.
7. Pay attention to contracts.
8. Control management's perception of the project.
9. Be sensitive to the personality of the institution and the users.
10. Beware of buying too small. Needs should not outgrow the system before it has paid for itself. Careful forecasting will prevent this from happening.
11. Do not be afraid to use the public utility—it may be right for the institution.

New Technology

Deregulation has unshackled technology, which can now develop naturally. There is no question that the customer is in control of the market and is driving technology. Institutions no longer have to change the way they operate in order to fit the boundaries of the equipment. Managers can select the system that fits current institutional needs and that will be flexible enough to grow as requirements change in the future.

In the information age, greater demands are being placed on existing telephone systems to carry more information at faster speeds. To keep up with these demands, larger, more technically sophisticated telephone systems will be required. A newly purchased switch could be a cost-effective replacement that would be more functional and flexible and would have a capacity to meet future needs, especially in the area of data communications. The data communications requirement is particularly significant because of the increasing volume of communications from microcomputer to microcomputer and from microcomputer to mini- or mainframe computers on campuses today.

Areas such as housing, purchasing, and the registrar's and admissions offices can benefit greatly through office automation. To support higher levels of office automation with local area networks, electronic mail, and terminals having voice/data capabilities, a more sophisticated switch utilizing a single pathway is most desirable.

Managers investigating the switch market today should consider a

digital switch that allows the integration of both voice and data through the same switching system. The advantages here are the elimination of all modems within the system and the achievement of greater transmission speeds. Digital communications clearly represent the direction in which technology is heading.

Technology has also come a long way in the area of small key systems and basic telephones. With the newer electronic key systems all the common equipment is self-contained in small boxes that take up a fraction of the space of the older equipment, are easy to install, and are very reliable. Here again, largely because of competition, the price is reasonable—in most cases, less than $400 per station. And the cost will be coming down even more.

Two- and three-line telephones of the smaller, stand-alone variety can be purchased at low prices ($150 to $225) to replace the standard rented key telephone. Stand-alone telephones work nicely in situations that require a multi-line back-up station. For the most part they are easy to install and replace. On large Centrex systems with a heavy emphasis on key telephone service, the stand-alone telephone can fill a need at substantial cost savings and maintain the accustomed level of service.

Technology has also brought advances in the basic telephone. The old rotary and touchtone types have been joined by electronic "smart" telephones. The latter can supplement any system because they have features such as programmable memory, speed dialing for large groups of numbers, last number re-dial, built-in speakerphones, intercoms, and buttons that can be programmed with the main system feature access codes.

It should be emphasized that a thorough evaluation of the institution's present telephone situation costs nothing. Such an evaluation can help the institution gain valuable knowledge to apply toward the acquisition of a reasonably priced new telephone system.

Summary

Two factors will always influence decisions on the purchase of a switch: cost and management control possibilities. Regardless of the telephone situation on a particular campus, the telecommunications manager has an obligation to investigate the cost-saving and system-enhancing options available today (AT&T remains a very large company and will continue to influence telecommunications decisions).

The manager should immediately begin a thorough study of the current telecommunications system to determine:

1. Type of existing system
2. Kinds of services now provided
3. Current problems and limitations
4. Size and cost
5. Makeup of inventory
6. Present and future requirements for voice and data communications.

Some institutions will conclude that their present vendor is best for them, while others will decide that a new telephone system is called for. Today it is essential for the telecommunications manager to become involved in high-level telecommunications decisions in areas such as long-range campus planning and the development and utilization of new technology. Many decisions will require investments of millions of dollars. The era when managing telephones meant simply paying bills and overseeing simple moves is clearly over.

Deregulation and divestiture have brought much change and confusion. This is, however, a temporary situation and there is definitely light at the end of the tunnel. These are truly challenging times for the telecommunications manager, and the campus of the future has the potential to be one of the top beneficiaries of the divestiture settlement of 1983.

3
Selecting A Consultant

Telecommunications has been characterized as the least well-managed expense in American business and industry and, traditionally, in higher education as well. Managers of higher education have relied on their knowledge and experience to guide the development of telephone systems. Perhaps someone in purchasing or physical facilities had enough basic knowledge of the Bell operating practices to be able to order additional services as needed and to keep the billing from getting too far out of line with reality. In most cases, telecommunications expenses were relatively modest. There were few if any alternatives to the Bell services anyway, so this was an acceptable mode of operation.

Times have changed. The telecommunications industry has been revolutionized in the past few years. Competition has replaced monopoly. Any and all equipment can be purchased from a multitude of suppliers. The demand for data communication has become critical and grows rapidly. Over 200 vendors now offer long distance and other network services, with widely differing price schedules and quality of service.

With this revolution has come a change in the role of telecommunications consultants and an increased need for their services. That need has spurred tremendous growth in the number of consultants. With vastly different levels of experience and expertise and from different

types of organizations, they specialize in different aspects of telecommunications and are conversant with different industries and applications. Although most are highly ethical, some are not.

One result of the changes in the industry is that management is faced with new challenges, including those that center around the consultant: What does a consultant do? When should one be hired? Where can they be found? What is a reasonable charge for their services? How can one tell if a consultant is ethical, experienced, right for the job? Given the complexity of telecommunications today and the size of the investments being made, getting solid answers to these questions has become essential.

Why Hire a Consultant?

There are several basic reasons why an organization engages a consultant of any type. One is to obtain the benefits of specialized expertise. The purchase and installation of a new PBX system, for instance, are typically a once-in-a-career event for most administrators in higher education. Such purchases frequently run well into the millions of dollars. The installation process affects every individual on the campus, tears up real estate, and likely commits the institution to a course of action for a decade. There is little room for error; the job must be done correctly the first time.

It is most unusual to find a telecommunications staff with all the skills and experience needed to perform the many functions involved in such a large and specialized undertaking. There are many consultants, however, who have been through the PBX selection and installation process literally dozens of times. They understand the process. They are familiar with the vendors and the ever-changing array of products available in the market. Their specialized expertise can be invaluable.

Another common reason for hiring a consultant is to get the benefit of an objective viewpoint. Even if an institution is blessed with a highly competent, well-rounded staff, a second opinion is useful given the enormous stakes and risks involved.

An objective recommendation given by a recognized expert from outside the organization can help resolve the internal and external politics that frequently cloud campus issues. Political pressure can come from the senior engineering professor who understands communications switch design but has never had financial bottom-line responsibilities, or from the member of the board of trustees who also

happens to be president of a local interconnect company. Although this pressure often is not easily defused, competent consultants frequently have better success than internal personnel who have become part of the problem.

There are other reasons for hiring a consultant. Frequently a large project requires far more manpower than can be spared from day-to-day operations. Rather than attempting to add permanent staff, it is often less expensive to hire consulting services. This has been especially true in recent years with the rapidly rising price of experienced telecommunications talent. A fresh view of the institution's operations may make it possible to find solutions to problems that have resisted the best efforts of internal staff.

What Do Consultants Do?

The list of services available from consultants is long. Institutions may want to use only a few of the services, or to get more deeply involved. Typically, the larger the task at hand, the more specialized are the skills and experience that are needed. If the institution has a small staff, or assistance is needed in dealing with a specific political situation, more assistance may be required. The important point here is that the institution must determine the appropriate level of consulting involvement. This must be absolutely clear and must be conveyed to the consultant. From the following list it is evident that consulting firms are able to do almost anything an institution might want.

Some of the more common consulting services include assistance with the following issues:

- Long-range strategic planning: Where is telecommunications going in the institution? How is this function going to further the institution's goals? To whom should the telecommunications management function report? Should voice, data, and video be combined into one organization?
- Compiling an equipment inventory: How many stations of each type does the institution have? Where are they located? What is the nature of the cable plant?
- Current system evaluation: How cost effective is the system? Is the service level adequate? Can growth be accommodated? What construction will be needed to accommodate a new cable plant?
- Needs assessment: What new functions are needed? How can the institution take advantage of newer technologies such as voice mail and electronic text mail?

- RFI and/or RFP preparation: Conversion of operational and management needs into technical terms that vendors can understand and deal with is a special skill.
- Vendor proposal evaluation: A thorough knowledge of system architectures, features, and vendor reputations from past installations is crucial in any evaluation, as is a detailed financial analysis of the proposals.
- Contract negotiations: What is the vendor likely to be willing to give away? Where can the vendor be expected to draw the line?
- Installation project management: Even turn-key contracts do not always run smoothly; an experienced watchdog is invaluable and often mandatory.
- System acceptance testing: Designing performance criteria for system acceptance and then making certain that the system performs according to those standards prevent many problems later on.
- Network design: What is the campus's relationship to the rest of the organization and the rest of the world? How should the institution communicate in the optimum manner?
- Education and training: With a new system, every user will need some training. Designing a good training program is essential to success.
- Organization design: How many in-house managers and analysts will be needed once the system is installed? How many maintenance technicians, billing clerks, other types of employees?
- Software selection: What type of management software will be needed? Where will it come from?

Consultants can get involved in most of these issues at varying levels. It is up to the institution to determine the level of support it wants and needs. One approach to compiling an equipment inventory, for example, would have the consultant designing an inventory system and in-house staff conducting the inventory itself. Some consultants have enough staff to perform the whole job. Typically, vendors supply a certain amount of user training for new systems. The consultant can, however, assist in specifying the nature and extent of training when writing the RFP, and can supervise the vendor's performance. Consultants will generally be of most value doing those things for which the institution does not have qualified, available in-house staff. While it makes sense to have a consultant assist in strategic planning or system evaluations, it makes little sense to pay him or her to count telephones.

Choosing the Right Consultant

Great care must be taken in selecting the right consultant for the task at hand. Consulting firms in this area have proliferated and range in size from one-man shops to divisions of very large management consulting and "Big 8" accounting firms with offices across the country. Some corporations, having developed a sophisticated telecommunications staff to deal with their own internal problems, have later turned that staff into a new division of the company, selling consulting services to outside users.

Size is not a good determinant of quality. There are advantages and disadvantages to both large and small firms. The personal attention and commitment that are frequently offered by very small firms are harder to find with the larger organizations. On the other hand, many one-man shops may lack the technical depth of manpower needed for very large, complex tasks. The name and reputation of the "Big 8" firms give them great credibility. They have large staffs that usually represent a broad spectrum of technical understanding and experience. Partly because of their size, however, they tend to operate in a more highly structured and formal manner than smaller firms and tend to be relatively expensive. Many of the small firms are more specialized. Their approach can more easily be tailored to the needs of an individual institution. And such firms are frequently less expensive. However, with a smaller staff may come lessened stability and a limited perspective.

Cost is an equally poor means of choosing a consultant. The least expensive consultant may, in retrospect, turn out to be so inept as to be very costly. On the other hand, the most expensive is not necessarily the best either. Rates run from $300 to $1,000 or more per day, plus travel and lodging expenses. While this may seem high, it must be kept in mind that consultants pay office rent and require administrative support personnel just as any other professional. In addition, they must spend a large amount of time just keeping up with the industry, and this is time for which they are not compensated. In an age when the work of telephone service technicians is billed at $90 per hour, even $1,000 per day for good consulting services does not seem exorbitant.

Most consultants will quote a fixed price, or a range with a minimum and maximum, for performing a specific task, usually with a stated rate per day for extras outside the agreed upon scope of work.

One important implication of this is that the institution must convey clearly to the consultant the exact scope of work, and the consultant must understand and agree. Negotiating a detailed contract with the consultant is advisable.

Other means of computing compensation are less common. For example, the use of contingency fees, where payment is a percentage of the annual savings realized as a result of the consultant's recommendations, has declined in recent years. This approach tends to produce large savings by promoting major surgery on the existing system, only to leave the patient—after the fee has been paid—near death's door because the level of service is no longer adequate. At this point, much of what was removed in the cost-saving effort must be replaced. Some consultants charge a certain amount per line based on system size. Obviously this can lead to over-building of the system. Whenever possible, both the contingency fee and the per line approaches should be avoided.

Naturally, organizational size and cost should be two of the factors considered in selection of a consultant. A partial list of other factors includes the following:

- Does the consultant have any experience with systems of the institution's size and type? A 10,000-line voice and data PBX installed on a 500-acre campus requires many skills not needed with a 400-line switch confined to one building.
- Is the firm experienced with working in the higher education environment? Most firms that do not have such experience find it difficult to understand that higher education institutions consist of loose confederations of independent contractors, and fail to realize the highly complex political nature of colleges and universities.
- Has the consultant ever worked in a public bidding situation (if that applies)? Public purchasing rules are very different from those that apply to independent institutions and a misstep on the consultant's part can invalidate the whole process and cost months of time and effort.
- Does the consulting firm have any outstanding lawsuits? These are not necessarily a negative factor; in this highly litigious society the consultant may indeed be innocent. Still, a lawsuit is cause for further investigation.
- Does the consultant have any apparent biases? Many who have entered the consulting business since the breakup of the Bell System carry personal biases either strongly for or against AT&T that may work to the institution's disadvantage.

Answers to some of these questions can be supplied by the consultant. Other information can be obtained only through third parties. The consultant's references should be thoroughly checked through administrators at other institutions and managers in business and industry who have dealt with the firm. Contacts available through membership in local and regional telecommunications organizations and industry-specific organizations such as the Association of College and University Telecommunications Administrators (ACUTA) are absolutely invaluable and can provide a wealth of information. A consultant's membership in various organizations such as the Society of Telecommunications Consultants indicates a level of professional commitment and ethics as well.

Questions as to how a particular consultant "fits" the institution can be answered satisfactorily only through actual interviews with prospective consultants. Many consulting contracts run for a year or two, especially for major projects, and it is important for the "chemistry" to be right. One of the advantages of a small-to-medium-sized firm is clearly that the individuals with whom the institution is dealing before the contract is signed are likely to be the same persons who will be doing the actual consulting.

Working with Consultants

Styles of operation vary greatly among consultants. One extreme is the expert who is reluctant to reveal the reasons for making specific recommendations. This consultant spends time at the institution analyzing and coming to understand needs and problems and then disappears. Later he or she materializes on the doorstep with a complete set of recommendations and solutions. Those at the institution have no idea what goes on between meetings, and they are unlikely to find out. The other extreme is a consultant who merely repeats the solutions that he or she thinks you want to hear, whether they are correct or not.

A more desirable approach to consulting is to be not only an expert and a leader, but an educator and trainer. One goal of both the consultant and the client should be to educate the institution and its personnel. Eventually, the consulting contract will terminate and the task will be completed. From then on, the permanent staff will be expected to continue to run the system and justify and implement decisions and plans made with the consultant's assistance. A good understanding of the reasons for those decisions and of the operational basics of the sys-

tem is crucial for the long-term success of any project.

It is essential to develop a good working relationship with a consultant. This is greatly simplified if the duties and responsibilities of the consultant and the institution are clearly established in the contract. During any project in which another vendor is involved, such as the installation of a new PBX, the relationship must include the vendor. Some consultants attempt to act simply as intermediaries between the vendor and management, dominating the project. A more beneficial structure is one in which the consultant helps the institution and the vendor to understand each other's problems and positions so that mutually agreeable solutions may be reached.

There is no easy formula that will always lead to the selection of the right consultant. The decision depends on the unique situation of the institution—on its needs, the funds available, existing personnel, politics, and personal preferences. Consultants should be seen as simply one important resource among many. Exercising care in selecting and dealing with a consultant will provide many benefits to the institution.

4

Financing A New Telephone System

The purpose of this chapter is to inform business and finance officials and telecommunications managers at both public and independent institutions about their options in financing new telephone systems. The discussion will not focus on the operating lease/ownership decision, which is influenced more by the relative obsolescence of an institution's equipment than by the lack of financing options (telecommunications consultants are likely to be the most knowledgeable parties regarding the effects of divestiture on current operating lease rates). The discussion here will summarize the financing options available to higher education administrators, whose goal is clearly to ensure that the system is financed at the lowest possible cost to the institution.

Public Institutions

In most institutions, the telecommunications manager has responsibility for the quality of communications on campus and is usually the most informed campus official concerning how structural changes in the telecommunications industry will affect the university. Involvement with a telecommunications consultant will help the manager to become aware of some of the financing options available. From the beginning the telecommunications manager should work closely with financial staff so that the limits of what the institution can afford are

clear. Such teamwork should be established before the system is bid. (If there is no agreement on how to pay for the acquisition, it may be wasteful to hire a consultant and spend the time to create the RFP. The finance officer of the institution should be the author, or at least coauthor, of the financing section of the RFP.) If a telecommunications consultant is hired, he or she usually incorporates vendor financing proposals in the request for proposal. Once responses are received from vendors, the manager and the finance officer should catalog what their options are and which option will enable the institution to obtain the lowest price for the equipment. It must be pointed out, however, that overriding political considerations sometimes prevent choosing the option that offers the lowest price.

Cataloging the Options

Though it is not possible here to outline specifically all the options available to all public institutions, the following list provides an overview.

1. Appropriations: A lump-sum line-item appropriation by the state legislature for the amount needed to fund an institution's telecommunications system might be the least complex option. For two reasons, however, most legislative bodies are unlikely to do this. First, because of the decline in federal support and the increasing demands for local assistance, most states are not in good enough financial condition to be able to commit to a major new capital expenditure. Second, and most importantly, there is already a budgeted stream of revenues for existing equipment, usually for an operating (nonownership) lease. For most legislatures the existence of a previously budgeted line item in an operating budget is sufficient justification to deny requests for the same item in the capital budget.

2. Excess cash: A few institutions find they have sufficient excess cash to finance a new system, but this is, of course, not the case with most.

3. Debt financing: A third method is some form of debt financing. The debt can be issued directly by the university and secured by the pledge of student fees and tuition, or it can be issued by a state building authority and secured by annual appropriations of the state legislature. In many states, particularly in the East, this may be a viable alternative. However, particularly in the West, states such as Colorado do not have statutory authority to issue bonds for other than "auxiliary" enterprises. Dormitories, student centers, and recreation facilities at

such institutions are most often financed through a student fee assessed solely for the purpose of retiring the bonds. These institutions do not have the legal authority to issue bonds for the purpose of acquiring "academic" equipment, such as a telephone system.

In other states, such as Michigan, state law allows institutions to issue bonds for academic purposes without prior legislative approval, and tuition is pledged for repayment of the bonds. While this might seem a less complex option, universities in states permitting these transactions may find that students do not accept the use of tuition-backed bonds to finance the equipment or that administrators are unwilling to utilize the debt capacity for needs other than "brick and mortar" projects.

In many other states, the ability of a university to issue its tuition-supported bonds is subject to prior approval by the legislature. Given today's high federal deficits and associated political peril, most legislatures are wary of approving new debt financing for any projects.

It is important for the telecommunications manager to understand the institution's debt options and the political environment. The mechanics of the transaction are more likely to be the responsibility of the finance officer.

4. Vendor financing. Most telecommunications consultants recommend that each vendor be asked to submit separate financing and equipment bids when responding to the university's RFP. Vendor responses in the financing area tend to consist of introducing the university to third parties specializing in lease financing. Only the very well-capitalized and profitable telecommunications suppliers are capable of internally financing a university's systems. Indeed, suppliers offering this form of financing usually reserve the right to sell their leases to third parties. In the most popular form of vendor financing, the vendor introduces the university to a commercial bank, leasing company, or investment bank that actually provides the financing. Usually, the financing is not limited to the equipment being offered by the vendor. Generally, it is in the best interests of the university to separate the equipment selection decision from the financing decision.

5. Lease-purchase financing: Universities have long used lease-purchase financing to acquire various capital equipment items. (Lease financing is third-party financing. It is also frequently called an installment sale.) Such leases, when properly structured, are not considered a debt of the university or state; they bear tax-exempt interest rates; and they are typically repaid within three to five years. Title to the leased items passes directly to the university upon the final lease pay-

ment. Generally, these leases are nonrated, are relatively small in size ($5,000-$100,000), and are sold on a private-placement basis to sophisticated individual investors and financial institutions. Some leases have been for much greater amounts—in the $2.5 million to $6 million range. (The par amount of leases being privately placed has been increasing, in terms of the dollar amount referenced. Analysis has to be undertaken by the university to determine whether private placement can compete with the certificate structure in terms of interest cost.)

It has become clear that since new telecommunications systems involve major capital costs, a broader market for the sale of large leases must be developed. Telecommunications equipment costs alone at very large universities can now approach $40 million. In the late 1970s, investment bankers applied their experience in small-equipment lease financing to the design of a new lease-purchase finance program for multimillion dollar telecommunications systems. The program they developed provides cost-effective nondebt financing, with flexible repayment terms and conditions. Additionally, the leases can be sold at interest rates lower than small-equipment leases because of the marketing advantages of securing investment-grade ratings (from Moody's Investors Services and Standard and Poor's Corporation) and because of the emphasis placed by investment bankers on developing a much broader marketing approach.

Traditional small-equipment lease financing involved one lease for the total amount of equipment to be financed. Usually, the lease was sold as a whole to one investor because there was no legal mechanism for breaking the lease into smaller investment pieces. This structure would not be appropriate for the multimillion dollar leases necessary to finance telecommunications systems at many institutions.

A certificate of participation "splits" the ownership of the multimillion dollar lease into $5,000 increments. These certificates are structured in a manner similar to bond issues maturing serially over the financing term, and they pay interest semiannually. The interest portion of the payment is exempt from federal income taxes and may, depending on state law, be exempt from state and local taxes as well. (The Tax Reform Act of 1984 did not affect the tax-exempt status of certificates of participation. The marketing of certificates of participation can be enhanced by obtaining an investment-grade rating from Standard and Poor's or by insurance coverage. S&P looks primarily at the essentiality of equipment being financed, while the insurance companies will not insure beyond a seven-year maturity. The big equalizer

is the coupon, which can be 10 to 25 basis points higher than the university's revenue bond.)

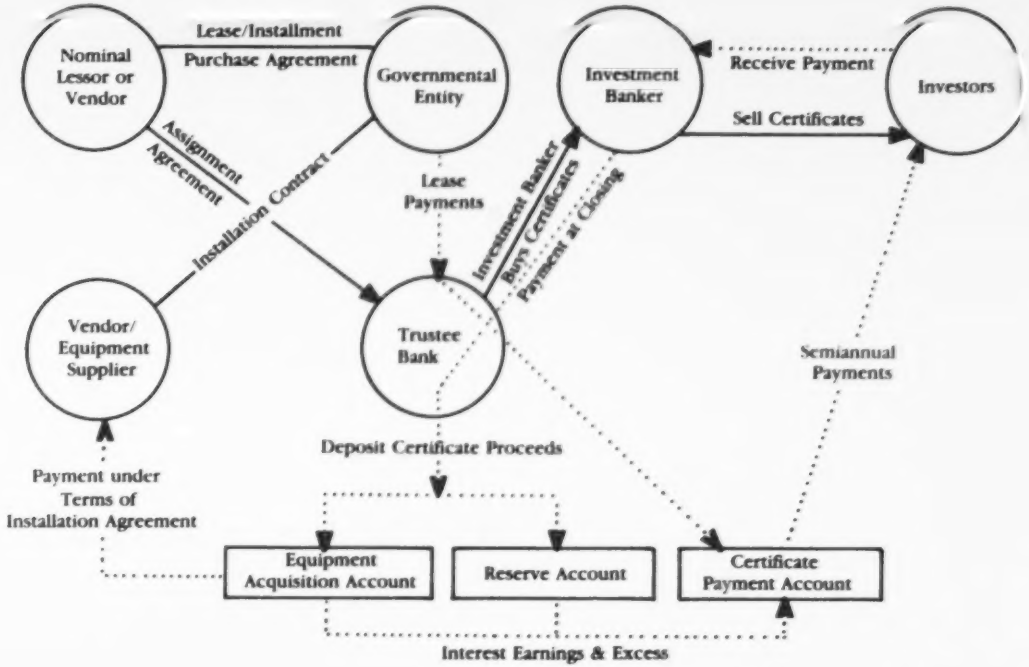
The structure allows the institution (i.e., the government unit) to make lease payments based on its cash-flow capabilities and on the estimated life of the equipment. Most lease-purchase agreements in the telecommunications area can be structured so that the lease payments coincide with the lease payment the university has made for decades under operating (nonownership) agreements. Ownership of the equipment passes directly to the institution upon remittance of the final payment. The university's obligation to make lease payments is designed to ensure that the lease will not be considered a debt under applicable state statutes and that it will not require legislative approval or diminish coverage ratios for student tuition or fee-secured bond issues.

Legal documents pertaining to the transaction are a hybrid of traditional bond and equipment lease financing documents. The terms and conditions of the lease are contained in the lease and agreement between the university (lessee) and the nominal owner (lessor). The lessor can be the telecommunications equipment vendor, a commercial bank, or a university foundation. The responsibility for monitoring the transaction, collecting the lease payments from the lessee, disbursing principal and interest payments to the certificate holders, and liquidating the equipment in the event of default or nonappropriation rests with the trustee, and is detailed in the trust indenture. The trustee is a third party, typically a large commercial bank or trust company. The certificates are sold by the investment banker pursuant to an official statement that summarizes the lease agreement and trust indenture and provides other pertinent information regarding the transaction and the university. These basic documents are drafted by nationally recognized bond attorneys and disclosure counsel. Figure 1 diagrams the contractual arrangements and cash flows.

Lease-purchase financing offers advantages that are consistent with a university's financing needs. The following are the primary advantages:

1. The lease does not create a debt for the university. Therefore, institutions in states where the constitution or statutes restrict debt financing can use a mechanism with features that approximate the traditional financing route.
2. The nondebt status of the lease-purchase agreement does not require the cumbersome process of legislative approval as in most financing.
3. The nondebt status also enables the university to avoid strict

Figure 1: Legal Structure, Cash Flows for Certificate of Participation Financing



application of the coverage ratios that are so common in student-secured bond transactions.

4. The lease-purchase agreement can receive investment-grade ratings from Standard and Poor's Corporation and Moody's Investors Services.

5. It is flexible enough to allow the maturity schedule on the lease to match the previously budgeted operating lease (nonownership) payments. No new money needs to be requested from the legislature since it is already included in the "base."

6. The lease-purchase mechanism allows title to the leased equipment to pass free and clear to the government unit upon the final lease payment.

7. The lease-purchase mechanism provides that control of the equipment that is financed vests with the government unit.

Determining the Financing Option

It is important for the finance officer and the telecommunications manager to be familiar with the key variables that are unique to the institution's situation. Several factors influence selection of a financing method for a telecommunications system.

1. Legal constraints: The two most important legal issues to be resolved are the institution's authority (1) to issue bonds and (2) to enter into lease-purchase agreements. It is important to distinguish between traditional lease-purchase agreements and those that are publicly offered certificates of participation. Most universities have long used standard lease-purchase documentation for lower-priced items of equipment. This documentation may or may not stand the legal scrutiny that publicly offered certificates of participation will undergo. In most cases nationally recognized attorneys in the field of tax-exempt bonds need to be consulted.

2. Political constraints: The nature of the relationship between the university and the executive and legislative branches of state government can significantly affect the choice of a financing method. If the legislature exerts strong control over the issuance of debt, the use of a lease-purchase agreement without the consent or knowledge of the legislature might have severe repercussions. Similar problems could also arise between a university system and the executive branch of state government if a financing mechanism that has not been approved or used previously is chosen.

3. Capital cost of the system: A third factor in determining the

financing mechanism is the acquisition cost of the system. Many institutions under 5,000 FTE without a dormitory system can purchase an adequate system for less than $2 million. It might be easier for such an institution to obtain a lump-sum appropriation from the legislature for this amount rather than issue bonds to finance the acquisition. Likewise, a large institution of 40,000 FTE, for example, with a significant dormitory population would be more inclined to issue bonds or certificates of participation.

4. Technological obsolescence: The technology associated with telecommunications equipment is subject to rapid change and potentially rapid obsolescence. This factor affects the length of the financing more than the type of financing. The time standard that is becoming accepted as the preferable lease term is seven years, with some leases being extended to 11 years. The lease term is important in the lease transaction because the ultimate security is the system itself. In a debt transaction the ultimate security is the pledged revenue stream, so the life of the equipment need not be an important consideration. Underwriters and rating agencies view the "essentialness" of the telephone system as greater than that of most other equipment on the campus such as administrative data processing equipment. They are, therefore, more comfortable with a somewhat longer lease term for an integrated telecommunications system.

5. Budgeted cash-flow analysis: The acquisition of a new telecommunications system can be accomplished within the framework of already budgeted appropriations, or what is commonly called the "base." Legislative or executive branch budget analysts will recognize the existence in an institution's budget of the current expenditure for telecommunications equipment. This will make it difficult for the institution to pursue "new" sources of revenue to finance a replacement system, whether by lump-sum appropriation or legislatively authorized bond payments. Such a situation could make lease-purchase financing attractive because the maturity schedule of the lease can be adapted to match the currently budgeted expenditure for the nonownership lease.

Independent Institutions

Generally, independent institutions have the same type of financing alternatives as do public institutions; however, the financial instrument used may be very different. Alternatives for the independent institution include:

Internal Financing
- Endowment
- Reserves
- Operating funds

External Financing
- Bonds—public or private
- Public (legislative) funds
- Secured lease
- Other (usually secured) debt

Internal Financing

Endowment Funds

One area that may offer an attractive financing mechanism for an independent institution is the use of endowment funds. This can be done in one of two ways. First, in the event that the institution has sufficient available funds to support directly the acquisition of a switch, direct purchase can be considered. It is obviously very important to determine that this is the "highest and best" use of the funds, since expenditure of endowment funds for a project of the magnitude of a switch significantly reduces the liquidity of the institution's portfolio, and also affects future income streams. Further, the legality of such an expenditure of funds must be determined, particularly if restricted endowment funds are involved.

Alternatively, endowment funds may be used as an internal source of funds for borrowing. This should involve determination by the institution of the appropriate rate of return to be credited to the endowment earnings (and charged to operations), along with an appropriate amortization schedule to restore the endowment principal at the end of the communication system's life. An accurate determination of this rate should include such factors as the return received from the alternate investment of these funds and a reasonable estimate of the interest rate that would be charged in the financial markets for financing the switch. (Obviously, if the income rate exceeds the cost of financing, borrowing from endowment should not be used as a source of funds.) The legality of borrowing from endowment funds should also be determined.

Reserves

Depending on the accounting methods of the institution and its fiscal policies, reserves may be available for equipment purchases. Since

it is unlikely that large amounts of funds have been set aside for purchase of a switch, the accumulation of reserve funds toward a second purchase should be considered. To the extent that reserves are available, they can also be very useful as a source of funds for tactical projects, such as purchase of telephone sets or long distance controllers, to enhance the present system, or for short-term borrowing to structure a complete project. Using reserves, however, always requires proper accounting/auditing procedures and validation of the need for the funds.

Operating Funds

It is possible to use operating funds to finance major acquisitions, at least in part. But the displacement of expenses is often miscalculated and overstated, as communications switches are dynamic and must always be expanded. Sufficient operating funds (or reserves for ongoing enhancements) must be available for the purchase of additional items needed as the switch expands. Thus, use of operating funds for direct financing should not be relied on unless the assumptions about growth and ongoing expense reductions can be shown to be reliable. Most of the unreliable assumptions in the analysis of financing plans result from overestimating the availability of funds.

Operating funds should, of course, be used for the acquisition of expendable items, or for the temporary payment of items until a long-term instrument can be prepared. It is advisable to avoid external financing of expendable items or the carrying of short-term items into long-term debt.

External Financing

The forms of external financing for independent institutions are quite similar to those that can be considered by public institutions. But the market and legal requirements may be quite different, reflecting the difference in control and the diversity of state legal requirements.

Bonds

Bond issues have become increasingly important in the last few years and now account for roughly 50 percent of telecommunications placements. Bonds may be issued either on the basis of public authority—which will often yield lower interest rates—or privately through

bond counsel and underwriters. (It should be remembered that legal and financial requirements for bond issuance vary from state to state.)

Placement and marketability are dependent on the guarantees provided and securities pledged against repayment. (The ability to place is very much dependent on the financial rating of the issuer—guarantees by a state authority or agency make placement easier. Bonds issued by an independent institution without guarantee have limited marketability.) In any case, bonds are an extremely important form of financing. There are strong arguments in favor of using bonds for acquisition of a communications system at an attractive interest rate, provided that the institution can secure a favorable rating in the financial markets and is willing to provide appropriate security for bond repayments in the form of pledged future income.

Public Funds

In many states, provision has been made for the use of public funds by independent institutions. This may be in a form such as housing bonds or equipment allocations from the state legislature to the Board of Regents for distribution to independent institutions. Public funding may consist of grants for specific purposes (such as equipment), a portion of a state educational bond issue, and other items. The amount of these funds may be limited, with allocations based on institutional size, or they may be available on a "first come, first served" basis. There may also be specific conditions regarding the use of such funds—e.g., term, purpose, expected lifetime of the equipment to be purchased, and others. While such "strings" may pose problems, substantial interest rate advantages can be gained, and it is even possible that outright grants could be obtained.

Leasing

Leases or lease-purchase agreements are often used by independent institutions to acquire a communications system. They must be arranged by the vendor or placed privately through institutional contacts. Leasing is most complex in relation to operational activities—it requires accurate identification of parts, inventory, and other items as to source, replacement, and ownership. Leases or lease-purchase agreements may be entered into directly with the manufacturer of the equipment, or, as is more frequently the case, with a third party as lessor. Only the very largest manufacturers are willing to enter into direct agreements; even in those cases the agreements can usually be

assigned to a third party at the option of the vendor. A variety of concerns must be addressed when purchasing a communications system under a lease agreement. These range from possession of title to the equipment during the lease to specification of remedies that may include liquidated damages. For example, if items are stolen or destroyed, or are outgrown, are sums due and payable immediately or are payments to be made over the remaining term of the lease? Do the institutional auditors take the same position as the lessor? Is the institution obligated to continue making payments on the lease to the third party or assignee while it attempts to recover from the manufacturer/distributor?

Other Debt

Other debt can be used when the institution is willing to offer other assets as security against borrowings to keep communications equipment unencumbered. Unsecured debt will probably not be very attractive to lenders. Certainly, the use of other assets, such as stock or other investments, as security is an alternative that can be used to raise "equity money." The institution must determine—as a matter of policy—whether it is prepared to make such a commitment and whether this action is appropriate.

Fund Raising

Finally, administrators should not overlook the possibility that the financing of a telecommunications system may be an attractive fund-raising opportunity for development personnel.

Structuring the Financial Arrangement

The institution must analyze its present cost of communications and determine what the future behavior pattern for this cost is expected to be, assuming no change in the system for one future "switch lifetime." After identifying this stream of revenue, which involves making some assumptions about regulatory behavior in the case of Centrex or vendor behavior in the case of a leased PBX, the institution will be able to identify the projected dollars for a "steady state." (The "steady state" cost of maintaining present equipment is often overstated: by vendors with a vested interest in doing so, by users fearing the ravages of the deregulation process, and by the regulated suppliers themselves, who are afraid that customers will accuse them of deception should their forecasts turn out to be too low. Suppliers from the unregulated

side of the industry *may* be able to give more accurate, long-term estimates of the cost of maintaining present systems.)

The institution must relate the projection (in net present value terms) to the strategic plan by citing the necessity to reduce projected costs, the desire to maintain competitive position by presenting a "state of the art" image, or other considerations. This will allow comparison of bid proposals and institutional priorities.

How is a bid proposal evaluated, in financial terms? Obviously, analysis of the basic proposal for net present value or payment schedules is similar to that for any contract. Certain items relating to the operation of a communications system should also be identified. The structure of the financial arrangement must take into account the variable life expectancy of the components of the system. This will often lead to identification of weaknesses in the "averaging" effect of an overall agreement, which would suggest that a different overall life expectancy be used for the communications system.

All too often, the total price is used to establish total dollar requirements without determination of the various periods of economic use of the parts. In many cases, such an analysis will change the parameters used to determine the viability of financing alternatives.

The following elements should be considered when calculating the overall cost of the system:

- Cable plant: Interbuilding, from a telephone company demarcation point. This may in fact be one or more points depending on the size of the campus or the configuration of the switch. Technologies can include twisted pair, fiber, microwave, or others.

  Intrabuilding, consisting of cabling, risers, etc.

  Additional requirements for cable include conduits, meeting the plenum ceiling code, gel-fill or pressurization if required, fuses, cross-connect boxes.

  Cable plant facilities should be oversized to accommodate potential growth. While there is an element of danger, the amortization period of an oversized cable plant can be spread over a longer time period than a switch—it also is more likely to have a higher percentage of salvage value, although the cost of removal may offset this advantage.

- Switch: This consists of the processor, matrix, port terminations, and memory, all of which have separate lifetimes and/or limitations.

Certain ancillary functions are also usually included—long distance controllers, databases, station detail recorders, power failure bypasses or backup power supplies, processors for electronic mail, and others.

Switch proposals normally include a one-year warranty period. Depending on the bid specifications of the purchasing institution, this period may be extended. The typical bid cost for this longer-term maintenance is rolled into the five- or ten-year period of amortization, although no benefits are received beyond the first or second year.

- Terminal equipment: This ranges from dormitory telephones (which could be treated as disposable) through single-line sets (which have a longer lifetime) and proprietary sets.

- Linkages to the central office: This is usually treated as part of the switch. The revenue stream used to amortize the purchase of a switch must allow for inflation of the ongoing costs of such linkages. While not strictly a part of the financial arrangements, adequate financial forecasting of these items is necessary to determine appropriate arrangements.

The financing arrangements must address all the assumptions made earlier in the process of identifying the preferred bid, and, based on the complete and detailed analysis of that step, the financing agreement must be structured to ensure that proper amortization is occurring. A less-than-ideal decision as to switch selection can be tolerated if the assumptions of switch cost and life cycle were accurately determined; if the financing arrangements were based on improper life cycles, the institution will face major financial problems in liquidating and salvaging its position.

The analysis of each of the components is extremely important in order to call into account all assumptions made in switch selection. If the financial analysis shows that an improper overall assumption was used to evaluate alternatives, the institution runs a substantial risk of being left with a "stranded" investment at the end of the switch's life cycle. With proper assurances that the switch financing will not exceed the useful life, the institution can be somewhat assured that even if the decision turns out to be less than ideal, a reasonable level of service can be maintained within financial constraints.

Analysis may show that switch selection has been driven by a preference for particular technology or by the availability of a specific

amount of funds. It is important that institutions not allow either technology or financing alone to drive the choice. A balance must be reached so that an institution does not find itself with more equipment than it can pay for or with equipment that becomes outmoded too quickly because sufficient funds were not available to obtain an adequate system. The trade-offs at that point—or consideration of an alternate choice that was not previously looked into—must involve the range of communities of interests on the campus. An institution must live with a communications system for a relatively long time—it is a major investment, not to be replaced in one or two years. Thus, all segments of the community must be reasonably satisfied with the choice.

5

Telephone System Technology

Prior to 1970, most college and university telecommunications responsibilities were limited to tracking bills and coordinating telephone company service requests. In the mid-1970s, when companies such as ROLM and Northern Telecom began selling alternatives to telephone company offerings, institutions of higher education entered a new era of telecommunications planning and management. As the effects of divestiture and deregulation are felt more and more broadly, good management becomes more and more crucial.

Today, there are a host of telecommunications choices and alternatives that institutions face. Because a college or university is a center of information, effective information transport systems are essential. The campus environment, with its distributed layout and diverse requirements, invites multivendor, multimedia solutions. Furthermore, the rising costs of higher education call for campuswide solutions rather than departmental solutions wherever cost effective. On one hand, this places a heavier burden on college and university business officers; on the other, it offers a new and exciting challenge. Now, more than ever before, institutions are finding it necessary to investigate the many technologies that fall under the broad heading of "telecommunications" in order to ensure that the campus will be served by the most appropriate systems at the best price.

The technology of telephone systems is fast merging with the technology of almost every other telecommunications system. The buzzwords of the industry are integration and interconnectivity. Some foresee a day of ultimate integration when all parallel networks will be eliminated. It is safe to say, however, that integration during the 1980s will be less a matter of eliminating parallel networks and more one of interconnecting currently segregated systems and networks. Examples of this interconnectivity can be seen as new PBXs are introduced that offer simultaneous voice/data transmission, direct access to T-1 facilities, access to public data networks, and access to local area networks (LANs).

Development of the PBX

Whereas telephone companies' central office equipment is part of the public telephone network, an organization's switching equipment is privately owned, rented, or leased. This equipment is known as a private branch exchange (PBX). The first PBXs were manually switched by operators using a cord board. Then came the Strowger step-by-step system, invented by a funeral director who became so upset at the local operator (who was sending all the undertaker's calls to competitors) that he created a machine to exclude the operator from the process. Over the years changes such as cross-bar switching were added to PBXs; but as computers developed, electronics for common control were added to the PBX and in the 1970s several companies introduced computerized branch exchanges, bringing on a whole new era in telecommunications. Those companies drew on their experience to integrate computer technology fully with telephone switching technology. The product quickly gained the eye of the market and the industry and spurred a period of rapid development. In essence, a new generation of PBXs evolved. PBXs are classified as follows:

- First generation: Voice-only systems with hard-wired logic and a rudimentary switching matrix. While they partially eliminated operator intervention, these systems had few user features and required the engineering of blocking levels.
- Second generation: Voice-only switches that utilized stored program control, thereby allowing a long list of voice features. Data transmission required modems, and speeds were limited to 4,800 bits per second (bps).
- Third generation: Switches allowing integrated, simultaneous voice and data transmission at speeds to 19.2 asynchronous and 56

synchronous. This generation utilized a universal wiring plan, and provided for direct T-1 interfacing, protocol conversion, gateways to LANs, integration of application processors, and a distributed architecture.

- Fourth generation: Switches incorporating all the third-generation capabilities, and integrating a local area network, be it a baseband, broadband, twisted pair, or fiber network.

In order to better understand the differences between the various categories of PBXs, it is helpful to understand a basic concept: analog versus digital transmission.

Analog versus Digital

While the majority of the telephone network is analog, digital transmission is quickly taking over as more and more digital transmission facilities (e.g., microwave and fiber optics) are installed. Likewise, the majority of the PBXs being sold today, as opposed to ten years ago, utilize digital transmission.

"Analog" refers to the varying strength of a transmitted signal. The sound we hear and the light we see are analog signals that vary in amplitude over the wide range of frequencies that make up the spectrum.

When we speak into a telephone handset, the microphone detects pressure variations created by the change in air pressure from our voice. These pressure variations are converted into current variations which are analogous to the sounds we have made.

Information can be transmitted through the PBX in either an analog or digital format (it should be noted that not all PBXs pass analog and digital information interchangeably). Digital PBXs convert our analog speech into a series of on/off pulses known as bits (binary digits). This is accomplished by sampling the analog wave and creating a series of pulses that represents the shape of the analog signal.

These pulses are then converted into binary words, which are then transmitted in a bit stream and can be interleaved with other channels by means of time division multiplexing (TDM), allowing for greater carrying capacity over that channel.

PBX and the Automated Office

The "automated office" is a buzzword that has been in use since the mid-1970s. PBX vendors and manufacturers have given much attention to the automated office in an attempt to ensure that the PBX is at its core. The following are very real moves in that direction.

PBX as a Link to Outside Databases/Computing Facilities

Many colleges and universities support "casual" data communications users. Unlike the software programmer or customer service rep who is tied directly to one computer on a full-time basis, the casual user computes on a limited basis and often interacts with more than one computing unit. This user *switches* from one database to another (e.g., from a mainframe to a mini or from a PC to a public data network), much as a telephone user switches from one call to another. The PBX is an excellent mechanism for switching.

Figure 1 shows the PBX switching for two types of applications: access to public digital packet-switched networks, and modem pooling for access to outside computers and databases.

In the first instance, the user dials the trunk number that has a gateway from the PBX to digital networks such as Tymnet or Telenet. In the second instance, users have access to a shared "pool" of modems and can dial out on voice-grade outside trunks. (Note that automatic route selection, queuing, and other PBX features can be used.) This would eliminate needless proliferation of modems for users who need this access on a limited basis. Additionally, modems could be pooled for calls coming from the outside into the PBX. Pooled modems make a resource more efficient by allowing it to be shared by many users.

PBX as an Internal Link To Computing Facilities

Just as the users mentioned above have access through the PBX to outside databases, so they also have access to internal computing facilities (figure 2). Mainframes, minis, or micros may be tied to the PBX to accommodate those users. Heavy users who interact with only one computer on a continuous basis would still use conventional hookups, but the casual user who needs to be switched to more than one unit could be placed through the PBX.

PBX as a Link to Peripheral Equipment

The first popular piece of peripheral equipment that was connected to the electronic PBX was a call accounting system. Call accounting systems are still popular, but applications processors can be dedicated to a range of additional ancillary services (see figure 3):

- Call accounting systems: Collecting, storing, formating, sorting,

Figure 1: PBX as a Link to Outside Databases/Computing Facilities

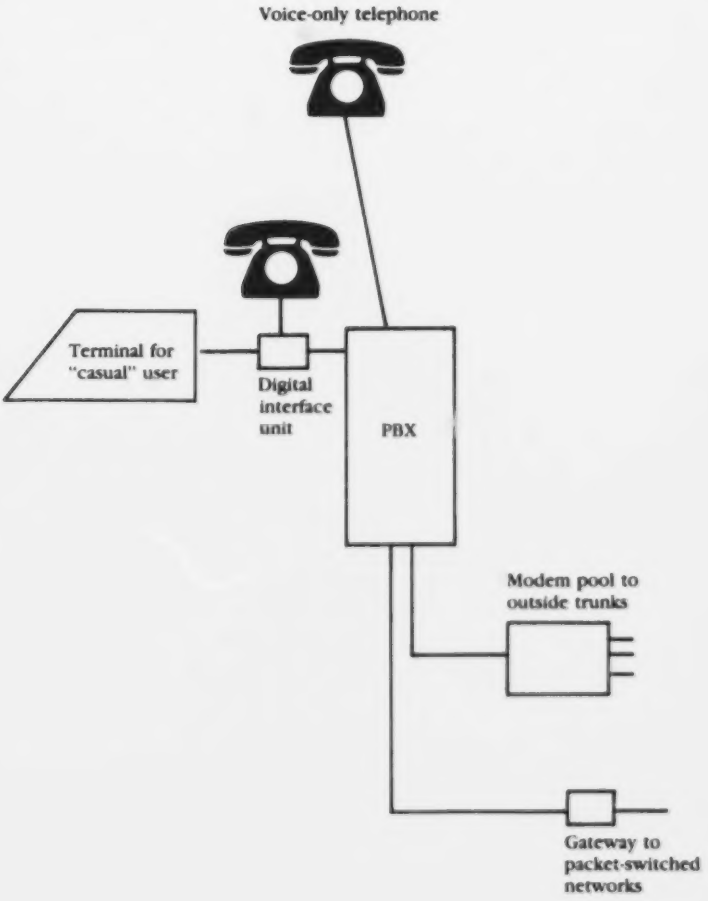
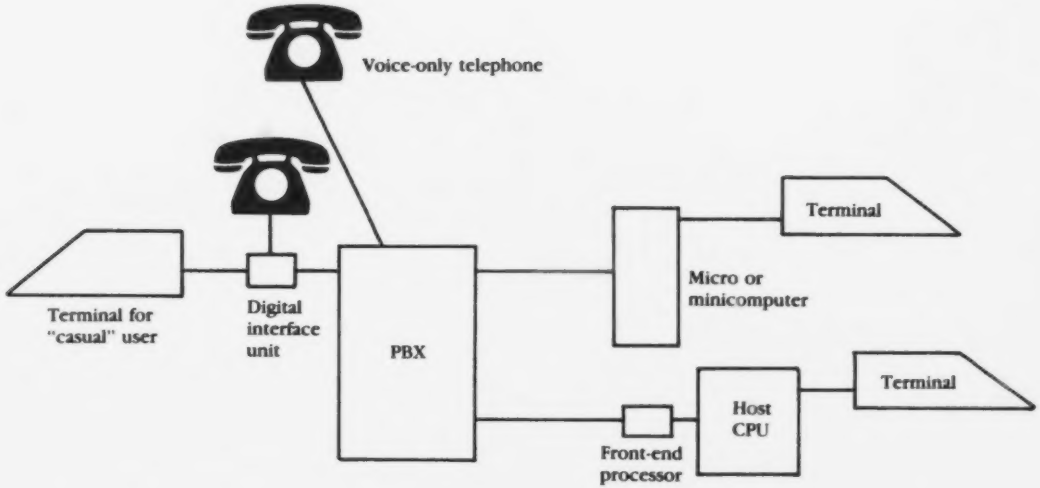


Figure 2: PBX as a Link to Computing Facilities



and reporting on all calls (both voice and data) placed through the PBX. This information can include number dialed, call duration, cost, time of day, and authorization and account codes.

- Directory: Storing of phone-book-type information such as name, extension, location, and organization number, as well as other user-defined fields. It greatly speeds operator call processing time and provides an up-to-date hard-copy directory.
- Energy management: Monitoring and administration of heating/ventilating/air conditioning activity.
- Facilities management: Providing of in-depth information for telephone bill-back, inventory control, work-order generation, and other information required for efficient management of the telephone system.
- Message center: Providing of coverage for unanswered calls. Calls are redirected to a group of agents who log messages on a CRT. The called party, upon returning, is notified that there is a message waiting. He/she can either call the agent for the message or have it printed.

PBX as a Gateway to a LAN

Through the PBX, a data user can have access to various local area networks (LANs), which facilitate high-speed data transmission between like and unlike devices within a building or a cluster of buildings (see figure 4).

Forces Slowing the Evolution of the PBX As an Automated Office Controller

As shown above, the PBX can act as a universal, centralized, and sophisticated voice/data system—a true automated office controller (see figure 5). Yet there are very few systems as sophisticated as this in the field because of forces that have slowed movement toward the automated office:

1. High cost of data interface units and data line cards.
2. High cost of electronic-digital telephone sets used to interface computer devices to the PBX.
3. The current state of confusion and uncertainty in the telecommunications field that is due, in part, to:
   a. Uncertainty about the IBM and AT&T cabling schemes.
   b. Absence of LAN standards.

Figure 3: PBX as a Link to Peripheral Equipment

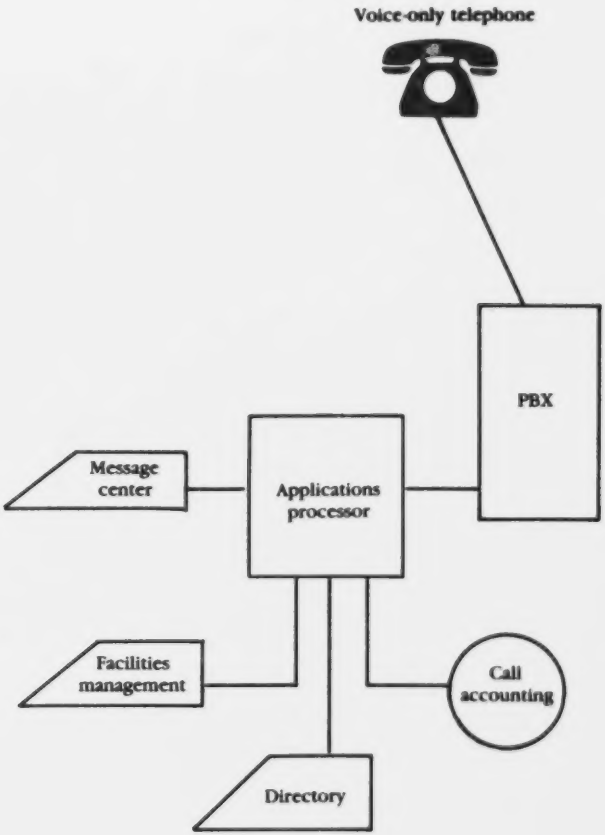
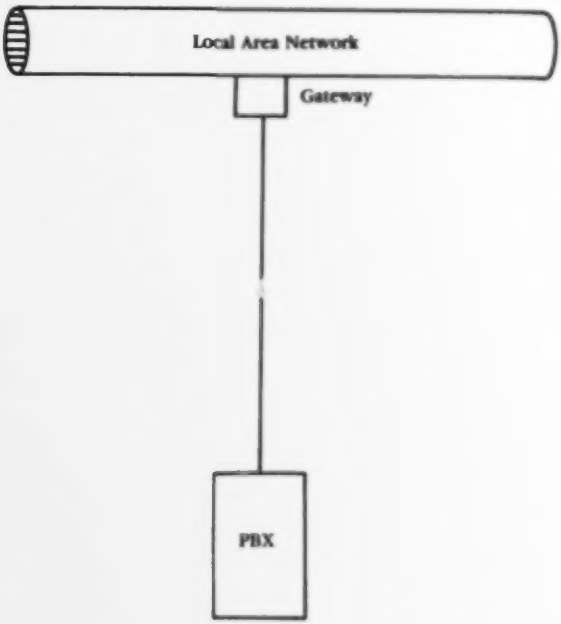


Figure 4: PBX as a Gateway to a LAN



c. "Newness" of many peripheral equipment products.

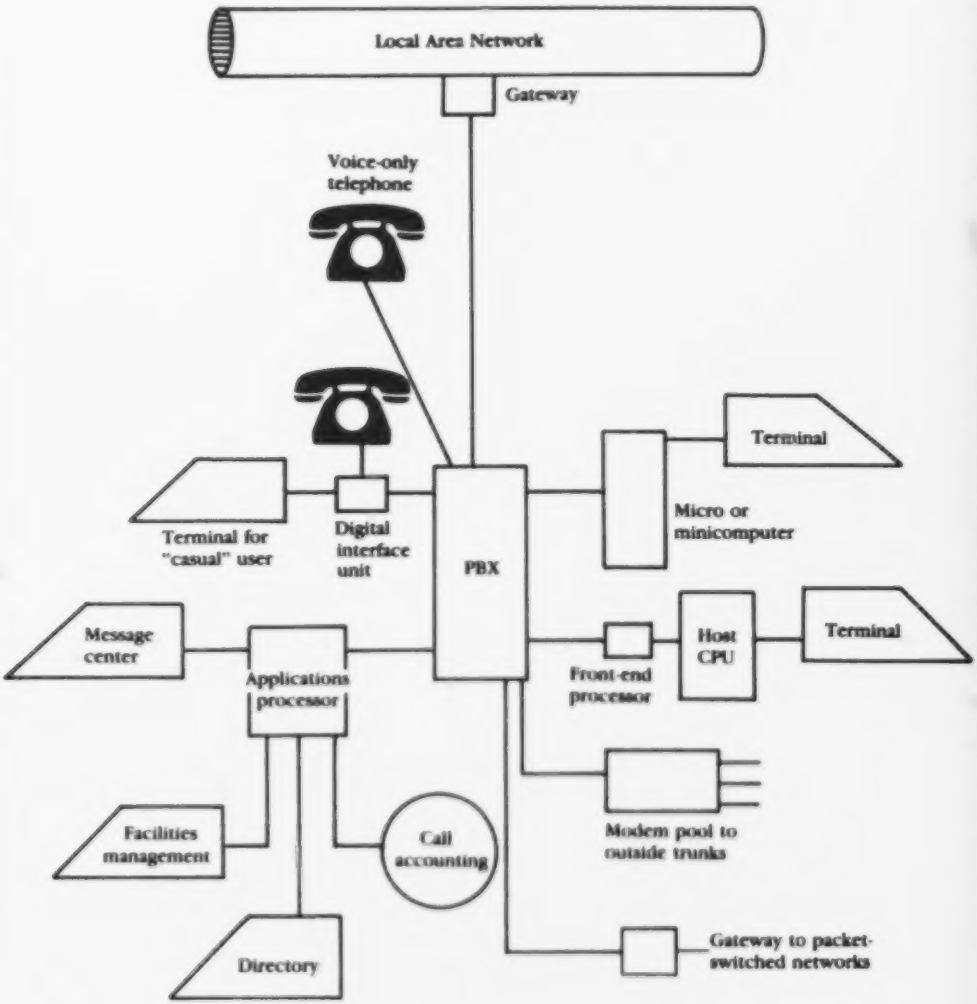
d. Difficulty in assessing future data needs.

4. Limited long-haul data transmission. While data transmission over long distance circuits is growing fast, it represents only 10 percent of the total traffic—a figure far below previous estimates.

5. Organizational structures of telecommunications departments. It is still rare today to find the "voice person" and the "data person" of an organization working together or within the same department. Until this organizational merging occurs, there will be a natural tendency to segregate voice and data transmission. Functional integration of departments must precede technical or applications integration.

In most institutions full integration of the PBX has not yet occurred. Yet there is a rising demand that the telecommunications manager

Figure 5: PBX as an Automated Office Controller



know about the other services, products, and technologies that can be or are being merged with PBX systems, such as:

Centrex
Fiber optics
Cellular radio
Microwave
Voice store and forward
IBM cabling plan
Local area networks
ISDN

Centrex

While Centrex is not an integrated PBX offering but an alternative to a PBX, it is mentioned here because of its position in the communications industry.

Centrex is a telephone company offering. Whereas a PBX is located on customer premises, Centrex is driven by a very large PBX that is most often located in the telephone company's central office. Thus, the customer does not use trunks; the circuits are actually lines—extensions off the Centrex central office switch. Every user has one line (except where lines are shared), making direct inward dialing (DID) possible. The following are benefits of Centrex:

1. Organizations that are located in a multipremise, noncontiguous layout (such as state or local governments) may be connected by one transparent system without incurring line charges or requiring microwave links.

2. All switching equipment is at the central office. This is very important in locations where real estate is at a premium and the space required for telephone equipment rooms becomes costly. Furthermore, the telephone company provides extensive maintenance and battery backup as the Centrex is also the central office for local telephone users.

3. If an organization expects frequent address changes, Centrex can be attractive because the organization is not required to purchase anything outright.

4. Additionally, Centrex users can choose from among the features available, paying only for those needed (although this has changed in many newer Centrex offerings).

Though Centrex is a service that many saw as being on the way out, it may be reemerging. In some situations it can be attractively priced;

in others, the cost is very high. It seems to have maintained a market niche and is, therefore, a service worthy of very careful consideration. Yet, as the pricing structure of Centrex is unlike that of a PBX, a detailed cash-flow analysis is required to ensure an "apples to apples" comparison.

Fiber Optics

With fiber optics, tremendous amounts of information can now be passed through a medium that is so small it has to be measured in microns.

Fiber optic transmission is accomplished by introducing light, either by a laser or light-emitting diodes (LEDs), into a very narrow, finely manufactured fiber made of glass or plastic silicon.

The advantages of fiber optics are considerable. First, it offers enormous bandwidth, and its data-carrying capacity is constantly expanding. Today, data rates of 90-100 kilobits per second (Kbps) are commonplace. Second, fiber is small in size and light in weight. Third, fiber offers a high level of network security as it is almost impossible to tap without detection (it is therefore used in many military and intelligence operations). Fourth, it is immune to electromechanical interference. The primary disadvantage of fiber is that, because it is difficult to tap, it is usually limited to point-to-point applications.

The fiber itself is made of three sections: a core consisting of one or more thin strands of fiber; cladding, which is a glass or plastic coating that protects the fiber from surface contaminants; and a jacket that is normally plastic and serves as protection against moisture and rodents.

Today, three types of cable are commonly used: step index, multimode, and single mode.

- Multiple paths of light are carried through a step index fiber. While this fiber, usually made of plastic, is relatively inexpensive, it has inherent signal loss that limits the distance over which it may be used to about one kilometer at fairly low data rates.
- Like step index fiber, multimode fiber guides light down several paths within the fiber. Yet the transmission qualities of multimode fiber are much better.
- Single-mode fiber is the smallest and most expensive of the three fibers. Light is sent down the fiber on one path. Currently, single-mode fibers are used almost exclusively for long-haul trunking. Because of the high cost of laser light sources and the performance

needs of applications at distances greater than one mile, this fiber will probably be the primary medium of terrestrial long distance carriers.

In fiber optics the transmitter generates a photon—a "shot" of infrared light; the signals are a series of light pulses. Therefore, the light source must be bright, directional, and capable of being turned on and off at an extremely fast speed.

Two light sources are common in fiber transmission: LEDs and lasers. LEDs are used over relatively short distances. While they are not as powerful as a laser, they are much less expensive. Lasers, on the other hand, can transmit a great deal of information over longer distances since they are powerful and emit light in a very directional manner. At the receiving end of the fiber, a photodiode converts the light by generating a current on the load circuit. Size, weight, bandwidth, and immunity to moisture, radio frequency, and electromagnetic interference ensure that fiber optic cable will be an important factor in new telecommunications networks.

Cellular Radio

When first marketed, mobile telephones were available to a limited number of users in a few major cities. The major obstacle to growth was the small number of frequencies available for mobile telephones—if the available channels were in use, a subscriber would be forced to delay a call until a channel became open. The advent of cellular radio has allowed for far greater efficiency in the use of frequencies allocated to mobile telephones.

This efficiency is achieved because the technology allows for the reuse of frequencies. A large metropolitan area is divided into small hexagonal cells. (The cells actually take on odd shapes, but are, for simplicity's sake, considered hexagonal.) Within each cell a group of frequencies is used, each frequency transmitting at power low enough so that the signal does not interfere with a nearby cell that is using the same frequency for another caller.

In the late 1940s, researchers at Bell Labs had conceptualized this idea of frequency reuse, but it was not practical until low-cost frequency synthesizers and electronic stored program control switches became available. These mobile electronic switching centers serve as (1) control between the telephone central office and the mobile user, as well as in mobile-to-mobile transmission; (2) status control of the mobile users; and (3) generators of billing information.

Allocation of frequencies is controlled by computer. The user is al-

located a frequency that connects his/her telephone with the cellular switch, which, in turn, is connected via land line to a telephone company central office switch. Should the user travel from one cell into another during a conversation, the system detects the move and switches the connection to a new frequency without, in most cases, disrupting the call.

Both analysts and vendors are predicting tremendous growth in the use of cellular radio, especially in large metropolitan areas.

Microwave

Commercial microwave communications emerged from the development of radar during World War II. Microwave utilizes those frequencies above 1 gigahertz (Ghz)—generally, the 2, 4, 6, 8, 12, 18, and 23 Ghz bands. Prior to the use of microwave, land lines were the primary means for long-haul transmission. Microwave became a way to transmit a wide band of frequencies without having to deal with the problems of property easements, rights of way, and trenching.

As noted above, microwave uses frequencies that are at the high end of the radio frequency spectrum. This is important because the higher the frequency, the more there is loss of signal, and the more the signal behaves like light and travels in a straight line. Whereas signals at the low end of the spectrum bend with the curvature of the earth, microwave transmissions travel only within a line of sight; this further limits the transmission distance (climatic conditions such as rain or fog also affect distance).

Frequency	*Transmission*
2 Ghz	30-40 miles
6 Ghz	20-30 miles
12 Ghz	10-20 miles
18 Ghz	3-9 miles
23 Ghz	2-4 miles

In order to extend the distance, repeater stations must be added. These stations perform as a "hop": the signal is received and then retransmitted to either the next hop in the network or the destination point.

The first step in planning a microwave link is to determine whether there is a line of sight between two points. This line must be clear of mountains, buildings, trees, or any other object that may obstruct the

transmission path. Second, a frequency search must be made to ensure that there are no other signals that would interfere. FCC approval is required. In a case where repeater sites are necessary, property rights will have to be secured before construction of a transceiving facility can proceed.

Technological cousins to microwave systems are light-wave systems that can serve as a link between two sites. These systems are much like microwave, but they modulate infrared light. Whereas microwave travels in a line that is *almost* straight, a light wave travels in a line that *is* straight. Light-wave systems can be used over very short hauls such as across streets or down city blocks, but they are usually limited to less than one mile. The major disadvantages of light-wave systems are that they are very sensitive to rain or fog and they are limited in transmission distance. The major advantages are that they are small and do not require FCC licensing.

Voice Store and Forward

Voice store and forward (VS&F) systems, also referred to as voice mail or phone mail, are computer-based switches that record, store, and retransmit voice messages. When an outside or internal caller enters the system, the computer digitizes the analog signal, forwards it to the receiver, and converts the digital bit stream back to analog in a synthesized voice message.

VS&F resembles telephone answering machines in that the product is a recorded message, but that is where the similarity ends. VS&F systems provide the following unique features:

- Messages may be reviewed and edited by the calling party.
- Messages may be broadcast to a group of people at one time (a manager can notify staff that there is a meeting).
- The calling party can exit the system to gain access to an operator or secretary.
- The system may be shared by a group of users, with authorization codes protecting the privacy of the messages.

At present, VS&F systems are expensive, but they reduce the amount of "telephone tag," address the problem of lost messages, and enhance the overall communications of an organization by eliminating repeated, nonproductive call placement.

IBM Cabling System

In May 1984, IBM announced its cabling system, which is designed to allow a local site (building or campus) to be interconnected within

a uniform, structured design. IBM's statement of direction indicated that by prewiring a building during construction or renovation, the cabling system would allow:

- New devices to be quickly installed.
- Easy relocation of devices from one office to another.
- Simple network reconfiguration.

The wiring system allows for connection and migration support of the broad range of products in the IBM computer family as well as optional telephone system wiring. In addition, the announcement stated IBM's intention to implement a star-wired, token-ring local area network within the next two to three years.

Basically, the cabling plan is composed of three elements: cable, patch panels, and face plates.

- Cable: These are IBM-qualified cables for both voice and data. They are available in an assortment of combinations that include voice- and data-grade twisted pair and optical fibers that may be chosen to meet the specific requirements of the site.
- Patch panels: Central to the cabling plan is the use of distribution panels that are located in wiring closets throughout the site. These rack-mounted panels permit cross-connecting of users, offices, and other wiring concentration points. It acts essentially as a manual switch much like the manual PBXs of 30 years ago. Panels have 64 patch points, and each rack will support up to 128 patch points, or two panels.
- Face plates: The cables are terminated at the user location or prewired site into receptacle face plates and surface-mounted receptacle devices. All face plates allow for a single data connector, and an alternate face plate allows for both a data connector and a telephone jack connector. The cost of these receptacles is high, but should be reduced in the near future.

The first installations of the wiring plan met with mixed reviews. It is expensive and it creates a whole new set of issues regarding space planning. In addition, the cabling plan has been introduced in a manner suggesting that the specifications may be refined. Nevertheless, the plan cannot be overlooked as it is the product of the largest computer manufacturer in the world. Surely much more will be heard about the IBM cabling plan.

Local Area Networks

The first computers were very large batch processing machines that were centrally located and run by computing personnel. In the 1960s

terminals were located close to the computer (usually in the same room or in the next room), and they transmitted at low speeds on a time-sharing basis. In the 1970s minicomputers were developed. These could be distributed throughout a large organization and could be used for specific departmental tasks. In the 1980s there has been a proliferation of microcomputers. Many persons who never before had access to computing power now have a computer on their desk.

This gradual distribution of computing facilities has created new needs within organizations. Individuals, each with his/her own computer, are requiring their own printers and software. Furthermore, each computer has become an island of information unto itself. And this is where the local area network (LAN) comes in.

LANs serve as a network for high-speed data transmission between computer users and computer devices, enabling organizations to share printers and software programs, to gain access to data networks and other data devices, and to transfer files between machines.

Unfortunately, it is difficult to define a LAN because many vendors claim to have LAN products and there are no standards. However, a "working" definition could be as follows:

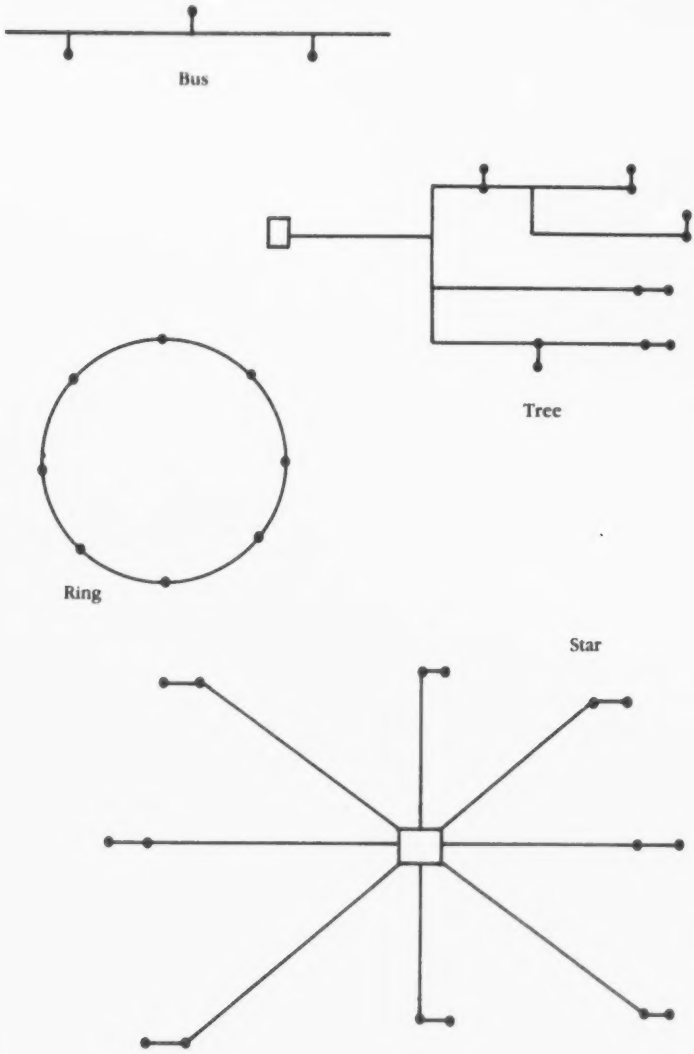
> A LAN is a network situated within a building or cluster of buildings that allows for high-speed data transmission between a variety of like and unlike interconnected devices.

LANs can be categorized by topology (how they are physically configured), transmission medium (e.g., coaxial cable or twisted pairs), and access method (how users get into and share the network).

Topologies are, for practical purposes, limited to ring, star, linear bus, and branching tree configurations (see figure 6). Transmission media vary in the topologies and bandwidth they support. The media used by LAN vendors include twisted pair, baseband coaxial cable, broadband coaxial cable, and fiber optics.

- Twisted pair may be used on the ring, star, bus, or tree, and bandwidth can reach up to 1-2 megabits per second (Mbps). The major drawbacks are that the wire lacks ruggedness and is susceptible to noise and crosstalk.
- Baseband coaxial cable supports ring, bus, or tree topology and can transmit up to 10 Mbps. It is more immune to noise than broadband, but interference can be a problem. The main advantage is that it is easy to install and tap.
- Broadband coaxial cable is used in a bus or tree situation. The total bandwidth can be up to 450-500 megahertz (Mhz). Networks that use this type of cable are difficult to design, install, and maintain,

Figure 6. Local Area Network Topologies



but they are comprehensive and support simultaneous use of voice, data, and video.

- Fiber supports either a ring, star, or tree network. While installation is very costly and the technology is somewhat experimental, the bandwidth can be quite high.

Access methods determine how a user "gets into" or shares the network. The most common access methods are frequency division multiplexing, time division multiplexing, token passing, and CSMA/CD (carrier sense multiple access with collision detection).

- Frequency division multiplexing: This technique is used to divide a broadband medium into subchannels, thereby allowing for multiple access to one medium.
- Time division multiplexing: A technique common to digital PBXs, this permits interleaving of digital information into one bit stream.
- Token passing: Used in both ring and bus networks, the token passes from node to node; possession of the token allows the user to transmit.
- CSMA/CD: This access method calls for stations to "listen" before they transmit (if the channel is open, a station may transmit). In the event of a collision (two stations transmitting simultaneously), a jam signal is sent to clear the medium and an attempt at retransmission is made.

It is predicted that by the end of the 1980s LANs will represent a multibillion dollar industry. Currently, there is a vendor free-for-all (with over 200 LAN vendors), which has created a high degree of confusion. LANs are becoming increasingly important for organizations with high data use, and it is certainly worthwhile for such organizations to sort through the confusion.

ISDN

The integrated services digital network (ISDN), like the LAN, is an important new technology that is just around the corner and ready to become widely used. More than anything, ISDN is a concept, the idea being to reduce the number of parallel networks and place as much communications as possible over one medium. ISDN has its origins in Europe; development has been under way globally for 10 years, and much of the standards work is completed.

In fall 1984, a standards committee issued a set of ISDN standards. The goal was to move from an analog network to an integrated digital

network. The definition of ISDN given by the committee is:

> A network, evolved from the telephony network, that provides end-to-end digital connectivity to support a wide range of services, including voice and nonvoice, to which users have access by a limited set of standard interfaces.

Conclusion

It is difficult to imagine a time when there will be no need for voice communications. Thus, it is safe to say that telephone systems will have a significant role to play in future telecommunications technology.

In looking at the history of telephony, it is clear that PBXs have changed more in the last 10 years than in the previous 75. Great steps have been taken toward the integration of voice and data and the elimination of parallel networks. Yet the change in telephone systems technology is evolutionary; before the day of complete voice and data integration (if that day is to come at all), there will be a period when systems will supplement and complement each other. Because media, technologies, and concepts will be going through rapid change during this period, it will be necessary for telecommunications planners to think in terms of integrating ideas and systems. Much as the contractor uses different tools and materials to build a house, the telecommunications planner will use the tools of the trade to build systems and networks.

Telecommunications managers, analysts, and planners will be required to have a broad understanding of telecommunications technology. The most important activity will be information transport, and with that will come the bridging of dissimilar networks. Ideally, this will mean the linking of previously isolated islands of information and the delivery of information in a cost-effective manner to those who need it *when* they need it.

6

Large-Institution Case Study: University of Tennessee, Knoxville

The University of Tennessee, Knoxville (UTK) is Tennessee's comprehensive land-grant and state university with an enrollment of approximately 27,000 students. UTK employs more than 7,500 faculty and staff and has a total annual budget exceeding $190 million. The main campus includes 216 buildings valued at more than $200 million and is located on 646 acres.

The fiscal environment within which the university has operated during the past decade was a significant factor in the university's decision to procure its own telecommunications system. Although the percentage of the state's total revenue base allocated to higher education compares favorably with such percentages in neighboring states, revenues produced by Tennessee's tax structure have been less than adequate to satisfy fully the funding levels recommended by the higher education funding formula. The period of recession in the mid-to-late 1970s compounded this problem by producing revenue shortfalls that resulted in several sizable impoundments of state funds. During this period of time, the UTK administration continued to place high priority on reducing costs of administrative services or holding them constant, thereby releasing resources for academic programs.

Telecommunications Background

In 1979 the vice chancellor for business and finance, the director of business services, and the manager of telephone services began serious discussions about the future cost effectiveness of the existing telephone system and the implications of its technological obsolescence for both customer service and maintenance. At that time, UTK telecommunications requirements were served by a CU Centrex (701B) switching device that had been leased from South Central Bell since 1969 and operated by the university's telephone services staff. The Centrex system provided adequate service to approximately 8,000 campus telephones during the lifetime of its installation. However, South Central Bell declared the system obsolete in January 1978 and at that time recommended to the university that it replace the Centrex equipment with Bell's Dimension PBX.

In consultation with UTK chancellor and members of his staff, business and finance officials elected to employ an external consulting firm to (1) assist the university in planning for its telecommunications requirements; (2) determine the potential alternatives for addressing these requirements; (3) develop bid specifications and evaluate proposals; and (4) assist in supervising the installation and subsequent evaluation of the system. Officials of the university systemwide administration supported engaging a consultant (and they supported campus actions throughout the procurement and installation process).

Selection of a Consultant

During summer 1979, UTK solicited proposals from four telecommunications consultants and received responses from them. (The number of telecommunications consultants in the industry has increased markedly since 1979.) Business and finance staff met with representatives from each of the firms to secure information about the educational background and experience of the firms' personnel and the size of the installations handled, to request the names of contact persons at those installations, and to determine the general approach taken by the consultants in handling such projects. These visits also allowed the consultants to gain familiarity with the institution prior to the submission of formal proposals.

Following these visits, the university contacted a number of references provided by the firms and asked the following questions:

1. Was the consultant's approach to the problem satisfactory?

2. Were detailed specifications, traffic engineering, growth, and all other aspects of the telecommunications project adequately considered?
3. Were enough of the consultant's staff members committed to the project and available when needed?
4. Were all costs included in the original proposal?
5. When was the work performed? Was it completed within the time promised?
6. Did you accept the consultant's recommendations? Were they beneficial to your operation?
7. Did the bid specifications developed by the consultant result in an undisputed contract award?
8. Why did you select this particular firm?
9. What type of equipment has your institutiuon installed? What is the number of main stations, trunk lines, WATS lines, etc.?
10. Would you contract with this firm for future requirements?
11. Were other consulting firms considered?

After reviewing responses to these questions and evaluating the written proposals (including the proposed schedules of charges), UTK selected Telecommunications International, Incorporated (TII) to assist the university in the following four-phased project:

1. Analyzing the telecommunications requirements of UTK and determining the feasibility of replacing the existing system.
2. Developing specifications for a system to meet those requirements in a cost-effective manner.
3. Evaluating bids.
4. Supervising the installation and cutover of the system selected.

The contract with TII provided that at the end of any one of these phases of consultation the contract could be terminated if the university elected not to proceed.

Deciding to Replace the Centrex System

UTK telephone services personnel and TII staff immediately initiated phase 1—assessment of requirements for telecommunications. On the basis of the analyses of cost, capabilities, growth potential, and data transmission requirements, the review team recommended that UTK replace the Centrex system. This study was comprehensive, and was conducted rapidly over a period of several weeks. A 10-year cash-flow analysis was performed that compared the Centrex system to the proposed schedule of costs for both a Dimension PBX and a private PBX

of comparable size. The preliminary analysis indicated the potential for significant savings ($4-6 million) over 10 years with a new switch. In addition to the projected savings in equipment costs, the reduction in the cost of moves and changes was estimated to be more than $40,000 annually.

Both the Dimension system and a private PBX of the type included in the analysis presented an opportunity for the university to obtain numerous features not available through the Centrex system, and both systems possessed growth capacity. Further, the Centrex (701B) switch was considered to be significantly noisier as a data transmission device, with transmission speeds below those of the more modern PBXs. On the basis of the findings, the university elected to move to the next step in the four-phased project and develop specifications reflecting current and projected UTK telecommunications needs. (Actually, the decision was not quite that simple. The proposed action produced some apprehension, given the historical reliability of the Centrex, the comfortable long-term relationship with South Central Bell, and the pioneering aspects of such a venture.)

Development of Specifications and Release of RFQ

On August 8, 1980, the university released its preliminary RFQ for the furnishing and installation of a telecommunications system. The schedule of events announced as part of the RFQ was as follows:

August 8, 1980	Preliminary RFQ released
September 15, 1980	Pre-bid conference
September 25, 1980	Final RFQ released; bids requested
October 12, 1980	Site tours
January 30, 1981	Bids due; public opening
February 1981	Vendors' presentations
June 15, 1981	Contract award
July 1, 1981	Installation begins
August 30, 1982	Cutover

The staffs of TII and of UTK's Procurement Office and Telephone Services Office developed a comprehensive set of bidding requirements and specifications for the telecommunications system. The university follows the general framework outlined in NACUBO's *Contracting for Services* manual, and particular attention was given in this situation to providing appropriate definitions, statements of bidder's representation, procedure for notification of ambiguities of corrections in bidding documents, requirements to be met in the event of mate-

rial, product, or equipment substitutions, and the procedures to be followed by UTK in communicating addenda to the specifications. Included in the specifications were the general statements of bid procedure and an announcement in very specific terms of the pre-bid conference and arrangements for site visits by the responding vendors. UTK's experience with this procurement and with a number of others suggests that a pre-bid conference is essential in such situations. Further, to help ensure a successful procurement, the basis for the evaluation of proposals should be spelled out in the specifications.

The specifications included requirements identified in a series of meetings with academic and administrative users and representatives from the student affairs division. The assessments included an inventory of existing equipment, features, and services as well as projected modifications, additions, and deletions.

Also included in the general specifications was the procedure to be followed in the evaluation of proposals. The university stipulated the following:

> The contract will be awarded to the bidder submitting the best proposal, considering the following criteria:
>
> 1. Prior experience in the field.
> 2. Organization, size, and structure of the firm. (Size will be considered in relation to work to be performed.)
> 3. Qualifications of staff to be assigned to the work. This will be determined from resumes submitted. Education, position in firm, and years and types of experience will be considered.
> 4. Firm's understanding of work to be performed. This will be determined by evaluation of time estimates for performing each step in the total services proposed.
> 5. Price per unit of service.
> 6. Technical, managerial, and financial points earned on evaluation compliance matrix.
> 7. Evaluation of other installation sites and references.

The university further stipulated that the contract award be made to the bidder meeting all the evalation criteria specified above and submitting the lowest "responsible bid" for all mandatory requirements listed within the university's specifications.

The specifications included the following statements regarding qualifications of bidders:

The Owner may make such investigations as deemed necessary to determine the ability of the Bidder to perform the work, and the Bidder shall furnish Owner all such information and data for this purpose as Owner may request. Owner reserves the right to reject any Bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy Owner that such Bidder is properly qualified to carry out the obligations of the Contract and to complete the work contemplated herein.

In determining the capabilities of a Bidder to perform the work contemplated herein, the following requirements will be given major consideration and should be thoroughly addressed by the Bidder:

1. Successful installation and operation of a stored program-controlled telecommunications system of at least 2,000 main station lines.
2. Availability of at least one system of the type proposed that has been operational for at least six months.
3. Status of bidder as the original equipment manufacturer or ability to obtain co-signatures on all contract/maintenance documents of the manufacturer.
4. Financial stability to supply, install, and support the Owner's system.

In addition, the Bidder shall provide the following:

1. Most current audited financial statement.
2. Information on current litigation (if any).

These stipulations were intended to ensure that the university selected a vendor with (1) adequate experience related to the type of installation UTK was considering, (2) stability of operations (required for continuing support), and (3) organizational structure and staff availability to do the work properly and on time. The university further attempted to communicate the rationale for the procurement decision to all parties to minimize the potential for a protest upon award of contract.

The technical equipment specifications included general requirements for the switching system, including stored program control, instructions for call processing, provisions for expansion, availability of visual and audible alarm signals and redundancy of critical electronics circuitry, and systems memory circuitry with redundant components capable of being switched into immediate service in the event of primary system failure. The system requirements addressed transmission

specifications for the switching system and station lines, trunk requirements, signaling, power, internal systems management components, access to the system for expansion and maintenance functions, provisions for full direct inward dialing, and retention of the existing phone numbering plan.

The system was required to provide the following features (this list overlaps somewhat with that on p. 89 of chapter 7):

add-on conference
alphanumeric display for attendant position
answer hold
area/office code restriction
attendant called number display
attendant camp-on
attendant control of trunk group access
attendant class of service display
attendant direct paging
attendant stations number display
attendant transfer—all calls
attendant trunk group busy lamps
attendant trunk number display
automatic recall
automatic station release w/ howler
busy verification of stations
call forwarding (variable . . . all calls)
call forwarding—busy line
call forwarding—don't answer
call hold—automatic callback
call hold (single-line phone)
call processing
call waiting-terminating
circular hunting
classes of service
console answering priorities
consultation hold—all calls
data privacy
diagnostic circuitry (self-diagnostic capability)
dial "0" trunks to attendant (fully extendable)
dial call pickup (group)
direct department calling
fixed night service
flexible intercept
flexible night service
flexible station—controlled conference
flexible station number plans
indication of camp-on to station
individual transfer—all calls
individual trunk access
miscellaneous trunk restriction
multiple console operation
multiple trunk groups
multistation/multitrunk conference
nonconsecutive hunting

The system specifications further provided for the cabling, wiring, and distribution system and capacities for academic and administrative users and residence hall users. The university elected to request separate proposals for these two segments of institutional users to evaluate the feasibility of including the residence halls in the system.

Special Data Transmission Considerations

At the time UTK released the RFQ, the available switches did not have the substantial data handling abilities of a number of today's systems. UTK had certain limited networks in place, including a CMS bisynchronous network, a DCA asynchronous network, and an IMS network. The university is currently planning to install a high-speed backbone to provide support for future networking requirements. The campus telephone system will be a node within the structure of that network.

The section of the bid specifications addressing data transmission requirements included the following statement:

> The system offered should minimally support data transmission in analog mode using owner-supplied industry-standard modems at speeds of up to 4800 baud. Station instrument design, system traffic support parameters, and any other relevant system parameters should be configured to support a growing amount of data traffic. Optimally, the system should provide significant data traffic support including direct digital station interface and simultaneous voice/data traffic.

Evaluation of Bids and Award of Contract

On January 30, 1981, seven firms responded to UTK's RFQ. These responses were subjected to comprehensive financial, service, and technical evaluations. The evaluation process included not only the thorough assessment of responses to the RFQ, but also a visit to installations by each of the seven firms of the specific proposed equipment (with the exception of one system that was not available for inspection).

The financial evaluation reflected 10-year cost assessments, including purchase price, maintenance costs, and estimated cost of moves and changes. Figure 1 displays the 10-year cost comparisons, assuming a seven-year retirement of indebtedness. Those costs included certain common charges for central office trunks, direct inward dialing, touch-tone, and tie lines and totaled $28,855 per month with a one-time installation cost of $13,090. Further, all costs of the system (trunks, direct inward dialing, and maintenance) were inflated by 9 percent compounded annually. The lease cost of the South Central Bell proposal was inflated by 36 percent at the end of each four-year contract period in accordance with Bell's variable-term payment plan. Figure 2

Figure 1: Cost Comparison, Seven-Year Retirement (000's omitted)

Year	*Centrex*	*Firm 1*	*Firm 2*	*Firm 3*	*Firm 4*	*Firm 5*	*Firm 6*	*UCS*
1	$1,427	$1,459	$1,834	$1,830	$1,904	$1,566	$2,486	$1,597
2	$1,556	$1,679	$2,070	$2,128	$2,076	$1,869	$2,022	$1,733
3	$1,696	$1,732	$2,124	$2,187	$2,124	$1,928	$2,056	$1,778
4	$1,848	$1,789	$2,183	$2,251	$2,176	$1,993	$2,093	$1,826
5	$2,015	$1,850	$2,246	$2,321	$2,232	$2,064	$2,725	$1,879
6	$2,196	$1,918	$2,316	$2,398	$2,294	$2,141	$2,769	$1,937
7	$2,394	$1,992	$2,391	$2,482	$2,362	$2,225	$2,817	$2,000
8	$2,609	$1,517	$1,730	$1,830	$1,656	$1,708	$2,869	$1,443
9	$2,844	$1,062	$1,091	$1,203	$973	$1,213	$3,731	$ 907
10	$3,100	$1,157	$1,189	$1,312	$1,061	$1,312	$3,793	$ 988
TOTAL:	$21,685	$16,155	$19,174	$19,942	$18,858	$18,019	$27,361	$16,088
POSITION:		2	5	6	4	3	7	1

Figure 2: Financial Evaluation Matrix Results

Company	*Composite Cost*	*Points*	*Rank*
Firm 1	$16,200,000	39,860	2
Firm 2	$19,252,000	33,756	5
Firm 3	$20,058,000	32,144	6
Firm 4	$18,937,000	34,386	4
Firm 5	$18,112,000	35,996	3
Firm 6	$27,462,000	17,376	7
UCS	$16,150,000	40,000	1

reflects the summary of the financial evaluation matrix that assigns a numerical score to the 10-year costs and growth costs. The maximum that could be achieved through the financial evaluation was 40,000 points. The system with the lowest total price received that maximum value. The systems lost one point for every $500 above the low bid.

Note: A 10-year period was used in this analysis and the preliminary feasibility analysis described earlier because of the availability of specific lease payment schedules for the Centrex and Dimension systems. Shorter time periods were used in informal analyses of the private systems because of the potential for replacing purchased equipment within a shorter timeframe. University calculations demonstrated that no change in award results would have occurred using five- or seven-year analyses. Depending on local opportunities and/or constraints, a shorter time period might be more appropriate—particularly if an institution anticipates replacing equipment as rapidly as technological change makes new systems more attractive.

The service evaluation focused the managerial organization, financial stability, experience, and past performance of the seven companies. A maximum of 40,000 points was possible in the service evaluation and the actual range of points earned extended from 28,125 to 37,750.

The technical evaluation included an initial assessment of compliance with several minimum specification requirements including stored program control, compatibility with AT&T precise tone plan, expandability beyond 3,700 station lines, expandability beyond 430 trunk lines, accommodation of a minimum of four consoles, FCC certification, and utilization of self-diagnostic routines. All seven proposed systems met these minimum criteria. The systems were subjected to the technical evaluation matrix that provided a maximum of 20,000 technical points. Each of the systems offered had the basic technical ability to address the telecommunications requirements of UTK. Only

Figure 3: Evaluation Summary

Bidder	*Financial*	*Service*	*Technical*	*Total*
Firm 1	$39,860	$28,125	$17,414	$85,399
Firm 2	33,756	32,500	17,345	83,351
Firm 3	32,144	36,500	17,778	86,422
Firm 4	34,386	33,750	16,459	84,595
Firm 5	35,996	37,750	17,559	91,305
Firm 6	17,376	37,125	17,412	71,913
UCS	40,000	34,875	17,184	92,059

very small variations existed in points earned, with a range from 16,459 to 17,778.

The evaluation summary in figure 3 reflects the total points earned by each of the seven firms in the service, technical, and finance areas. Universal Communication Systems, Inc. (UCS), which offered the NEAX 22 switch, received the greatest total number of points (and was also the lowest bidder meeting specifications).

The evaluation process was completed and the recommendations of the consultants received on May 21, 1981. Because of the magnitude of the project and the large financial commitment, the proposed award was discussed at the campus level with the chancellor and his staff, the academic deans, and the leadership of the faculty senate. During the next several months, UTK staff proceeded to secure approval from university systemwide officials and the Board of Trustees. They discussed the pending purchase with interested legislative officials and with the State Fiscal Review Committee (approval of the State Fiscal Review Committee was not required prior to execution of the contract). The university's presentation was invited by the committee's executive director, who was interested in the cost benefits that would result from the arrangement. The comments from committee members were positive and encouraging. (Generally, it is important to communicate clearly to various constituencies, including governing boards and coordinating boards, the facts surrounding a pending procurement as well as the justification for the purchase. Further, upon arriving at a decision, information concerning that decision and the rationale behind it should be shared with appropriate internal and external constituencies.)

During late summer 1981 and throughout the fall, university and UCS officials discussed the purchase contract and negotiated modifications that reflected the final requirements of the university. On De-

cember 18, 1981, the university and UCS entered into the equipment installation and maintenance agreement for the NEAX 22. The contract fully addressed the university's systems specifications and contained an installation schedule that met both university and UCS requirements. Three significant deadlines were included: a cutover for dormitory service during December 6-30, 1982; an in-service deadline of March 14, 1983, for dedicated data/special circuits; and a cutover of academic and administrative units on June 10, 1983. The contract also provided for a comprehensive training program for all employees (to be completed prior to the cutover).

Financial Plan

The contract between UTK and UCS gave the university the following three options for financing the telephone system:

1. Cash purchase at a cost of $6,113,317.
2. Lease financing through an independent third-party financial institution selected by UTK.
3. Lease purchase of the equipment through a leasing company provided by UCS. (If UTK elected to exercise this option, UCS was required to make a lease contract available for 120 months at a monthly rate of $83,136.)

The agreement gave the university 30 days to choose the option it would employ to finance the system. The university treasurer determined that the financial plan offered by UCS had interest rates that were significantly below the market at the time of the contract. The effective interest rate quoted by UCS was 10.91 percent compared with generally prevailing rates of about 13 percent. Accordingly, the university elected the financing provided by UCS. The contract gave UCS the responsibility for determining the timing for provision of a lease-purchase agreement and assigned to UCS the risk arising from changes in interest rates. UCS delayed its arrangements to complete financing until December 1982, at which time interest rates had declined to the lowest effective level since the date of the contract. UCS had saved a significant amount of money gambling that rates would decline.

Third-party financing was provided by UCS through First Continental Leasing Corporation of Dallas, Texas. During 1982, First Continental attempted to locate an institutional investor to handle the lease-purchase financing. Because First Continental was unable to find one investor that could take on the entire package, they proposed the issu-

ance of certificates of participation to divide the lease into smaller units that could be sold to a number of investors.

UTK agreed to cooperate with this arrangement because First Continental proposed to include a reserve fund that would be invested for the benefit of the university—therefore reducing the cost of financing (at that time the treasurer estimated the savings to be approximately $150,000). Normally, expenses would be paid by the university as the issuer of the certificates of participation; however, UCS had committed to financing the system and was thereby responsible for all expenses involved in the issuance of the certificates. None of those expenses were paid by UTK.

UTK provides semiannual lease payments to a trustee (C&S Bank of Atlanta). The university's treasurer reports that by employing this financing approach, the university realized the following advantages:

1. A net savings in financing costs of $205,000 over the life of the lease.
2. Under the original financial plan the university would have paid $83,136 per month for 120 months, resulting in total payments of $9,976,320. Using a conservative estimate of the interest earnings on the reserve fund, the total lease payments to be made by the university over the life of the lease will now be $9,392,721, resulting in a cost avoidance of $583,599 for UTK.

Conclusion

The telecommunications environment is changing rapidly and numerous improvements in equipment have occurred since UTK initiated the process described above. In particular, the data-handling capabilities of telecommunications switches have increased markedly. However, the UTK procurement process resulted in installation of a system that is functioning in a most satisfactory manner. The contract was awarded without protest and the campus community accepted the transition favorably. Further, considerable savings were realized. On the basis of the UTK experience, several observations can be made:

1. The new telecommunications technology works well.
2. Universities can successfully operate their own telecommunications systems.
3. Consultants can make significant contributions at relatively low costs.
4. Internal communication and consultation with a broad range of

representatives of key offices are most important in the development of specifications and, in some instances, the evaluation of bids. The UTK experience suggests that the chief business officer, procurement officials, telephone service personnel, legal staff, computer center staff, television services personnel, and physical plant employees should be directly involved. The chancellor and/or president must be fully informed and must support the effort. Deans, directors, and department heads should be well informed throughout the process—from the feasibility study through cutover—and they should be involved subsequently in evaluating the system's performance. Faculty and staff should be given periodic reports through institutional communication channels.

5. A pre-bid conference is essential for this type of procurement.

6. Clear delineation of the basis for evaluation of bids should be reflected in the bid specifications (this should be discussed in the pre-bid conference).

7. Well-developed training programs should be provided for all employees, beginning prior to the system cutover and continuing after the cutover.

8. Following the cutover of the system, periodic communications highlighting system features should be sent to faculty and staff. Most personnel absorb the key points during training sessions, but follow-up publications assure the use of a greater number of features. (Note: these communications are not intended to be substitutes for telephone usage manuals, which are crucial and should be distributed prior to the cutover of the system.)

9. All desk-type phones do not need all the features that are available. Generally, the basic instrument—using the built-in capabilities of the switch—will serve the needs of most administrators, faculty, and staff. A campus configuration that minimizes the number of "bells and whistles" will cost significantly less.

10. Planning for expansion of lines and instruments will prevent problems.

11. The resale of long distance service to students should be carefully considered. If handled properly, this approach can save students money as well as produce additional revenue for the institution.

12. University personnel and/or the consultant should regularly inspect the installation of the telecommunications plant to avoid such problems as underground cable being installed at too shallow a depth.

13. Data transmission needs should be assessed at the beginning of the project.

The university utilized the existing telephone services staff (which had been responsible for administering the Centrex system) to manage the new switch. Two additional employees were recently added to handle the collection of receivables from students (for the resale of long distance service), bringing the total staff to eight persons including the director. Several UCS employees are assigned to provide technical support for the system under the maintenance contract provisions. The office suite and equipment room occupy 2,680 and 2,807 square feet of floor space, respectively—which is less total space than was previously occupied by the Centrex system and staff.

7

Small-Institution Case Study: McPherson College

This chapter on the small-college approach to telecommunications needs has two main parts: (1) a case study of a mythical small college and (2) a case study of McPherson College. Each "stage" of the first part gives a brief look into the thought processes of the mythical college's business manager and a general discussion of the steps many small colleges could take in planning, implementing, or evaluating a telecommunications system.

Case Study: A Mythical College

Oracle College is a small, mythical four-year college in mid-America. It is residential and generally well maintained. The campus has approximately 25 buildings ranging in age from 5 to 70 years. The administrative structure consists of a president and several vice presidents. Most decisions are made by the vice presidents following recommendations from working committees.

The college currently has 300 telephones on campus, not including pay telephones, credit card telephones, or private lines installed by individuals. The switchboard is run during the day by one full-time employee; student employees work during evening hours. Not all buildings on campus have the same telephone capabilities, and several

offices must place all long distance calls through the switchboard. Because of equipment limitations, some lines are shared by four persons. No automatic recording of calls is available.

Employees are asked to turn in long distance telephone logs monthly. Accounting staff use these logs to make charges for calls. Maintenance, service, and equipment charges are not allocated to individual departments but are charged to operations and maintenance each month along with any unidentified long distance calls.

The business manager at Oracle College has heard a number of his colleagues at other institutions talking about changing their telephone system, and he is considering the steps to be taken at Oracle.

This business manager does not face a unique problem. The evaluation of campus telephone facilities should be done on a continuing basis. Even recently installed systems should be evaluated on a periodic basis, since technology and user needs are constantly changing. Becoming aware of the dramatic changes in the telecommunications field is a major step in improving any campus telecommunications system.

Stage 1: Forming a Committee and Selecting a Consultant

After reviewing the eight-month budget report, Oracle's business manager is even more motivated to investigate the campus telephone system. Since most major campus changes at Oracle are done through committees, he must decide which committee should handle the project—the Vice Presidents' Committee, the Campus Planning Committee, the Educational Policies Committee, the Long-Range Planning Committee, or a new committee. He must also consider the possibility of not using a committee at all.

Whether or not to involve a committee, or several committees, in the evaluation of the telecommunications system depends on several factors, including campus style, and time constraints. If telephones are viewed only as a basic utility that is provided for each employee, a committee may not be needed, and telephone service can be provided much as heat, light, and basic office furniture. On the other hand, the telephone system may be viewed as a basic tool with extended uses in areas such as security, computer access, energy management, and others beyond basic voice communication. If this viewpoint exists on campus, the input of numerous persons through a committee structure can be very helpful.

A committee may also be necessary if the administration desires a high level of acceptance on campus of changes in the telecommunica-

tions system. The basic reason for using committees on many smaller campuses is to involve a number of persons in reaching consensus decisions. Resistance to change can be overcome by stressing cost saving, improved communication, and better features available in a new system. Gaining acceptance for telecommunications changes usually requires much effort after a system is in place, and a committee can help in this process.

Generally, the business manager on a small campus is highly motivated to reduce the time involved in making decisions. If little time can be spent in investigating the telecommunications system and if a quick decision is sought, the committee approach should not be used. The decision as to whether or not to use a committee will depend somewhat on the uniqueness of each campus and its management structure.

If a committee is decided upon, it should be appointed according to institutional policy, be given a written statement of objectives and a workable time frame, and be composed of appropriate individuals. A typical committee might include the business manager, the maintenance director, an academic representative, and representatives from student services, development, data processing/computer science, and athletics. On many small college campuses, the admissions, development, student services, and athletic offices make the majority of calls, and these departments may have special needs beyond normal telephone usage. If transmission of data, in addition to voice, is important, a person with some technical skills should also be on the committee.

Small colleges frequently debate the use of a consultant whether or not a committee is being used. It is often difficult to weigh the short-term costs of the consultant versus possible long-term savings. References should be sought for all consultants under consideration. (See chapter 6, p. 70, for a list of questions to direct to institutions that have used a particular consultant.)

Before final selection of a consultant, the following should also be considered: the number of visits that will be made to the campus; the consultant's understanding of the campus community (as reflected in a proposal); the consultant's prior experience with similar institutions; the background and experience of the consultant's staff; and the size and complexity of previous installations.

Consultants being considered by the college should be required to list their immediate past 10 clients and the type of system implemented at each so that any patterns such as repeated installation of a particular brand of equipment can be noted. Also, consultants under

consideration should make their written communications understandable and should not deal excessively in telecommunications jargon.

There are several reasons for considering the use of a consultant in the telecommunications area. First, a consultant can help the consensus process if there is division of opinion among campus personnel. Second, the presence of a consultant may minimize any political problems with the local telephone company. Third, a consultant may be necessary to insure that the latest technical knowledge and legislative changes are incorporated in the decision-making process.

Stage 2: Determining User Needs

Later that week, the business manager casually mentions to a group at coffee break that he may investigate a new telephone system. Before an hour passes, he receives a memo from the director of development stating how important the fund-raising effort is and how necessary private telephone lines are to that effort. To quote the memo, "A donor should be able to call the development officer directly. We would not want to miss any opportunity to receive a gift."

Soon, the business manager receives a telephone call from the director of admissions: "The admissions staff will be doing a lot of telephoning this year and you know how crucial the recruitment effort is to the college. Our counselors will be calling people at night and on weekends, and it is very important that we have enough lines to handle these calls. It would really help if we had push-button telephones instead of dials—we could save several seconds on each call."

Later the same day, the dean of students appears in the business manager's office to discuss the new telephone system: "This would be the perfect time to install telephones in every residence hall room on campus. Students need to make contact with friends, families, and local businesses. The college can collect a telephone rental fee and collect for long distance calls every month. Also, dorm counselors need to have 24-hour access to the telephone system in case of emergencies. The students will surely be in favor of the change, based on the reactions of all those we have spoken with so far."

The food service director, also interested in a new system, reminds the business manager that food service employees "need to be able to call in by 5:00 a.m. if they are unable to work, and there is often a need to call in and out after the switchboard is closed. A new system will help to solve these problems."

Returning to his office, the business manager finds messages from

the academic dean, the athletic director, and the maintenance director. All three have indicated that they have ideas for the new telephone system.

This stage illustrates the type of reactions often received by the business manager when it becomes common knowledge that a new telecommunications system is being considered. Every person on campus feels he or she has some degree of expertise regarding telephones, which are such a common tool in everyday activities. Like many other decisions facing the business manager, choosing the telephone system must take into account user needs and the resources available to satisfy those needs. The committee should interview each sector of the college community to gain an accurate understanding of how the sector operates and what features might be useful in a new system.

In most cases, telephone system features must be selected based on performance, needs, and cost. Often the business manager and other committee members simply choose from a long list of the features and performance desired, determine the cost of these features, and select a vendor. All major vendors can give numerous references for the performance and features of their systems. Common features to be considered include the following (this list overlaps somewhat with that on p. 75 of chapter 6):

add-on conference
three-digit toll restriction
attendant busy lamp field
attendant camp-on
attendant class of service display
attendant conference
attendant console
attendant direct paging
attendant loop transfer
attendant station number display
automatic call back
call forwarding—follow me
call forwarding—busy line
call forwarding—don't answer
call hold
console—less operation
consultation hold
consultation hold—all calls
data line security
dial "D" trunks to attendant
direct-in lines
directed call pickup
dial call pickup
drawings, maintenance
drawings, installation
executive busy—override
fixed night service
flexible station controlled conference
flexible station numbering plans
flexible station selection
four-digit numbering system
individual transfer—all calls
meet-me conference
mixed station dialing
music on hold—system
nonconsecutive hunting
off-hook routing

off-premise extension
power
power failure transfer
serial call
station call transfer
station camp-on
station hunting—consecutive through dialing
tie trunks
toll restriction—type A
traffic measurement interface
trunk answer—any station
trunk-to-trunk consultation
trunk queuing
vacant number intercept
voice paging access

The determination of campus needs is the most difficult step in the information-gathering process. As every college administrator learns, there are differences between perceived user needs and actual user needs. The business manager must determine what is actually needed versus what is desired. Determination of these needs may be facilitated by individual interviews, surveys, and direct observation.

Investigation of current operating practices is a basic step in determining actual needs. What are current switchboard hours? Who calls after normal business hours? What offices make use of telphones on weekends? How much long distance calling is being done? When are peak usage hours? What is being done about restricting certain types of calls? These and other questions should be answered to determine how the current system is being used. This information serves as a guideline in designing specifications for any new system. It is also important to determine how flexible current users are regarding phone services. Can the development office make more evening calls? Can the athletics department do without a separate line for ticket sales? Does the food service department really need two separate telephones? New or additional features may allow certain offices greater flexibility in operations. The business manager should be alert to these opportunities when discussing possible changes in the system.

Future plans, both academic and administrative, need to be considered in determining institutional needs, as should contemplated changes in computer science offerings, data processing, cable television, and radio operations. Also, any planned building additions, renovation, or office moves should be noted and provided for in any new system. Changes in student population, residence hall preferences, and campus activities should be anticipated, if possible.

Two other areas demand consideration during determination of campus needs. First, the maintenance capabilities of current staff and the maintenance requirements of any new system should be compared. On-campus capabilities for maintaining a new system may be

lacking. If so, then the type of maintenance agreement available from particular vendors becomes more critical. Second, the record keeping and accounting requirements of a new system should be considered. The importance of tracking long distance calls and of charging usage to specific departments may vary with each institution, as may overall traffic patterns. The capabilities of each new system in these areas should be evaluated before any purchase is finalized.

Regardless of how thoroughly campus needs are investigated, the business manager needs to maintain perspective, remembering that not everyone can be satisfied, that money spent on this project means someone else's project must wait, and that there probably is a board member or large donor that could have made a better deal. In short, determining campus needs is a difficult process that can never be done perfectly.

Stage 3: Recommending a New System and Contracting for Components

After a six-week period of information gathering, proposal writing, meetings, and numerous other activities regarding telephone systems, the business manager breathes a momentary sigh of relief. He begins thinking about the presentation he must make in three days to "sell" the recommendation to install a new telephone system: "What items should I stress in the presentation? Should I say anything about features, installation, schedules, financing, and other uses of the system?"

At various points in the process of recommending a telecommunications system change, the business manager will probably make presentations to several different groups. Such presentations will be for the purposes of education, communication, and persuasion. Each presentation should be brief, carefully prepared, focused on two or three main topics, and aimed at the target audiences.

A presentation to trustees generally should stress the modern features of the system and the resulting cost savings. New telecommunications systems often enhance the institution's image, and this should be attractive to trustees. Presentations to administrators should generally stress new features (that will make their work easier), cost savings, and management flexibility. For faculty and support staff presentations, the new features for users should be stressed. With all groups, a general schedule outlining the dates for purchase, delivery, installation, cutover, and testing should be presented. Each group should understand that the schedule must remain flexible in order to make possible the best installation and operation.

Once a decision to install a new system has been made, the business manager should follow normal purchase procedures used when making major capital improvements. The following approach to contracting, taken from NACUBO's *Contracting for Services* (p. 3), can be used to ensure that important steps are not forgotten in the purchasing process:

Phase I: Establishing a Decision Framework
- Step 1. Investigate service characteristics
- Step 2. Identify service objectives
- Step 3. Develop performance specifications

Phase II: Evaluating Service Delivery Options
- Step 4. Identify various combinations of service delivery options
- Step 5. Identify all constraints on service delivery options
- Step 6. Compare costs of service delivery options

Phase III: Selecting a Contractor
- Step 7. Develop service budget
- Step 8. Prequalify bidders
- Step 9. Develop request for proposal
- Step 10. Solicit bids
- Step 11. Evaluate proposal

Phase IV: Negotiating and Managing the Contract
- Step 12. Develop the contract
- Step 13. Negotiate the contract
- Step 14. Administer the contract
- Step 15. Evaluate contract performance

Important aspects of any change in the telecommunications system are the cost and how this cost is financed. The business manager should consider financing alternatives and use the same criteria applied to other major purchase decisions.

Stage 4: Dealing with the Start-up Period

Three months later the new system has been installed. After only one week, the business manager receives a list of complaints:

1. "My telephone cord is too short." (four persons)
2. "The color of this telephone is awful; it should be hidden from view." (home economics faculty)
3. "Why can't I call long distance without going through the operator?" (athletics department)

4. "My telephone is in the wrong location; it needs to be moved immediately." (four persons)
5. "Why don't I have any buttons for holding calls on my phone?" (the college president)
6. "This instruction book is no help. How can I transfer calls and put people on hold?" (four persons)

The business manager thinks, "How can there be so many complaints about the new system? What am I going to do?"

Complaints about the reliability of the equipment are relatively rare. Any problems in this area are handled by the vendor and often are corrected in the testing period prior to cutover.

Other complaints can be minimized if the following steps are taken as the system is being planned: (1) the new system should be undersold; basic new features should be discussed, but users should be surprised by additional features found after installation; (2) users should be placed in general categories and told in advance of any restrictions applying to their service; (3) on small campuses users should be informed that no changes will be made until 30 days after installation (such a trial period allows users to become accustomed to features they might have complained about if changes were allowed from the outset); and (4) the vendor should conduct training sessions for users. These sessions should involve actual use of the system, and written instructions should be available for users to take with them. The importance of adequate training cannot be overstated. The lack of such training can seriously disrupt an installation and can cause months of unnecessary human relations problems. Vendors should be required to elaborate on the "who, what, when, and where" of the new system.

Continual evaluation of the telecommunications system is necessary to ensure proper usage, cost reductions, and appropriate reaction to changing needs. Input from users regarding features used and not used and suggestions for improvements should be solicited on a regular basis. Training sessions for new employees should be scheduled at least once each year to ensure that the system's features are being used as intended.

Stage 5: Keeping up with Developments

A year after his initial thought about changing the telephone system, the business manager finds the new system working reasonably well, satisfying its users, and saving operating funds. To himself, he says, "I'm finally through with telephones." Is he thinking clearly?

Changes continue to occur in the telecommunications area, and it is possible that business managers will never be "through" with the subject. It is necessary to be aware of events involving home computer usage, remote classrooms, data transmission networks, satellite networks, computer-based control systems, and new generations of computers. These will all affect education institutions and their telecommunications needs. It is also necessary to keep in mind that the newly installed system is only temporary and that another change will be made in the future. This temporary period may be extended by careful planning, maintaining flexibility in system specifications, and continual adaptation of system updates. However, replacement is only a matter of time.

The Experience at McPherson College

Located in McPherson, Kansas, McPherson College is a four-year, independent, liberal arts, residential institution with approximately 500 students. During spring 1981, McPherson College completed studies on the feasibility of installing a college-owned telephone system. As this possibility was explored, the idea of a broader campus communications network was formulated. Further research indicated that a communications network linking 15 buildings was desirable and feasible. A network system to handle telephone service, energy management, fire and security notification, and computer communications was planned.

Planning

Planning for the new system was carried out by the director of maintenance, his staff, and the business manager. Suggestions were requested from the campus community and were reviewed by the Campus Planning Committee before being sent to the director of maintenance for consideration. Policies relating to energy management and security were reviewed and acted on by appropriate administrative committees. However, the noncommittee approach was generally used for planning, selecting, implementing, and evaluating the system changes. Implementation of the network was planned in phases. Phase 1, the installation of the cable and telephone system, followed this schedule:

April 1	Review telephone systems, etc.
May 20	Finalize requirements

June 1	Request bids
July 1	Award contract
August 20	Cutover to new system
Sept.-Nov.	Evaluate

Phase 2, beginning in December 1981, involved installation of the energy management system; phase 3, starting in spring 1982, installation of the fire and security notification system; and phase 4, beginning in fall 1982, installation of the computer communications system. Because of the integration of the system and continual changes in technology and equipment, the original plans were frequently modified in terms of details, equipment, and procedures. Modifications are always necessary since the system is adaptive in nature, not static.

Equipment

The basic component of the network is Anaconda Corporation 100-pair cable. This cable was installed underground, or through existing tunnels, between 15 buildings. The maintenance building was selected as a control point, and the campus was split into halves for management purposes. All cable is connected to the central point and all systems are managed from the same location.

The telephone component of the network consists of the following equipment: a Mitel SX-200 Superswitch, a Texas Instruments printer, and 108 ITT push-button telephones. This new equipment replaced a 1950s Bell Telephone plug-type switchboard and basic dial phones.

The energy management component of the network consists of the following equipment: a Pacific Technology model 16-64 Load Manager, a PT model Basic 8 Load Programmer, a PT model Basic 4 Load Programmer, demand limiter, adaptive controls, remote temperature sensors, timeclocks, water meters, light panels, and several miscellaneous sensors. This equipment allows building schedules, calendars, overrides, and other items to be coordinated with heating and cooling equipment. The system determines when to start boilers and other heating and cooling equipment, and stops those functions based on time, temperature, or other factors. For example, the main boilers will not run if the outside temperature is above 50 degrees. In addition, different parts of buildings can be controlled separately, which is important for weekend workshops and classes.

The fire and security notification component of the network consists of the following equipment: a Spectronics Corporation model 320

Main Receiver Station, fire alarms, smoke detectors, series 640 remote stations, and water detectors. This equipment allows all campus buildings to be connected directly to the local fire department—a feature not available prior to this project. This direct connection has made it possible for the fire department to respond in two to five minutes, and has been a deterrent to false alarms. The number of unoccupied building hours, especially late at night and during the summer, was a concern in the past. However, the fear of an undetected fire, or flooding of basements, has been lessened considerably by the system.

The computer communications component of the network uses existing computer equipment and the cables of the basic system. This network has made computer access possible in all buildings. Additional work to complete an interactive terminal network is being planned in this area.

Savings

The cost of most of the installation and of all the equipment listed above, plus other necessary connectors, supplies, and spare parts, was $105,619. The savings associated with the different components of the network can be estimated and payback periods computed.

Basic charges for service and equipment prior to the changes were $2,419 per month. After installation of the new system, charges were $317 per month. Thus, annual savings are $25,224.

Savings associated with the energy management system are much more difficult to compute because of the presence of variables such as changes in weather, facility usage, scheduled work hours, student population, and equipment condition. During calendar year 1982, electric consumption declined 0.2 percent, gas consumption increased 18.4 percent, heating degree days increased 18.6 percent, cooling degree days increased 13.1 percent, gas rates per MCF increased 25.1 percent, and electric rates per KWH increased 7.6 percent. On the basis of the changes in heating and cooling degree days, a conservative estimate of savings from the energy system is $4,093 annually.

The savings associated with the fire notification system are minor. Because of local fire equipment, location of the college, type of structures, and other variables, the college already had low premiums for fire protection insurance. Installation of the system resulted in an estimated savings of approximately $250 per year.

The savings associated with the computer communications network could be substantial in the future. At this point, no additional invest-

ment has been required and there is no realistic way to estimate savings. For these reasons, the chart below excludes this component of the network.

System	*Investment*	*Annual Savings*	*Payback*	*Estimated Life*
Cable & Telephone	$ 57,300	$25,224	2.27 yrs.	15 yrs.
Energy Management	24,981	4,093	6.10 yrs.	15 yrs.
Fire Notification	23,338	250	93.35 yrs.	20 yrs.
Combined	$105,619	$29,567	3.57 yrs.	

Thus, the combined systems resulted in a conservative payback period of less than four years. The actual payback has been more rapid because of increases in telephone and energy rates. The estimated life of the components is overstated since a study is now being conducted to change completely the energy management system. The need for continual, efficient operations makes frequent reevaluation of the system necessary.

Since many institutions are considering the installation of user-owned telephone systems, an integrated communications network should be thoroughly explored. All institutions of higher education are concerned about and involved with energy management, fire protection, and computers. The network at McPherson College could serve as one model to be studied by an institution seeking to go beyond installation of a basic telephone system.

Glossary

This glossary is a compilation of general-use telecommunications terms. It is not intended to be comprehensive or to include all the terms that appear in the book. The glossary is followed by a listing of acronyms and abbreviations.

AC Alternating current.

access Point at which entry is gained to a circuit or facility.

access code The digit, or digits, that a user must dial to be connected to an outgoing trunk group. For example, the user dials "9" for a local trunk, dials "8" for WATS, etc.

acoustic coupling Coupling a data terminal or similar device to a telephone line by means of transducers that utilize sound waves to or from a telephone handset.

add-on conference Allows a station user to add a third party to any existing two-party conversation.

address Destination of a message in a communications system.

all trunks busy (ATB) All trunks within a group being occupied, or busy.

alternate routing Procedure of routing a call over another route when all first-choice routes are busy or unavailable.

American Standard Code for Information Interchange (ASCII) A code with seven information signals plus one parity check signal, designed for compatibility between computers.

amplifier Device that receives an input signal in wave form and gives out a magnified signal.

analog signal A continuously variable signal. Voice signals transmitted on telephone lines are analog, i.e., transmitted electrically in a form *analogous* to the spoken form.

analog switch Switching equipment designed, designated, or used primarily for circuit connections between users for real-time transmission of analog signals.

area/office code restriction Ability of the PBX system to screen the dialed digits (NPA or NNX), and then to allow or deny connecting of the call to the trunk. This is very effective for exchanges that dial only to weather, time, etc.

asynchronous Not synchronous. Having no set pattern, cycle, or speed of transmission.

attendant Operator at a PBX console or operating position.

attendant exclusion PBX feature that "locks out" the attendant from an established call.

attendant recall PBX feature that brings the attendant into a circuit to provide assistance for unanswered calls.

automatic call distribution System designed to distribute heavy incoming traffic evenly among clerks or attendants.

automatic number identification Equipment that identifies the telephone number of the line initiating a call in order to send this information to a message accounting system.

backbone High-density portion of any communications network.

bandwidth Range of frequency from its upper to its lower limit.

baud Unit of signaling speed. In an equal length code, one baud corresponds to a rate of one signal element per second, or one bit per second.

binary digit Unit of information in two-level digital notation that may be a "0" or "1." A member selected from a binary set.

bit Abbreviation for binary digit. The smallest unit of information that a computer processes. A bit can have two values—generally a "0" or "1," or in electrical terms an "on" or "off."

bit rate Speed at which signal bits are transmitted.

blocking Blocking occurs when a call, arriving at random, finds an ATB condition for the trunk group used for completion of the call.

broadband Describes a transmission facility having a bandwidth greater than 20 Khz, i.e., a bandwidth sufficient to carry several voice channels.

buffer (1) Interface unit designed to link circuits together but not allow excessive or unwanted variations in one to affect the other. (2) A routine or storage used to compensate for a difference in rate of flow of data, or time of occurrence of events, when data are being transferred from one device to another.

bug That which causes a computer program to malfunction.

bus (1) In transmission, part of a circuit that is used in common from one of several to one of several circuit functions or modules. (2) The name for a main power lead between rectifiers/batteries and telephone switching equipment. A bus can be a 100mm-diameter cable of stranded copper, or simply a track between circuits on a printed circuit board.

busy count Number of times all trunks in a group are busy.

busy hour The hour of the day the telephone system carries the most traffic.

byte Smallest addressable unit of information in data storage or memory (consisting of eight bits).

cable Insulated conductors assembled in a compact form and covered by a flexible plastic-like waterproof protective sheath.

cable, buried Cable that is placed in the ground without the use of a conduit (also referred to as direct buried).

cable, optical fiber Cable made of glass fiber protected by a plastic cover.

cable, pressurized Cable protected against moisture entry by the pumping of air or nitrogen under pressure from the central office. Leaks produce changes in pressure followed by an increased pumping rate allowing immediate notification of a problem.

call forward, don't answer Automatic rerouting to the attendant or a preprogrammed secondary station when a given station does not answer within a prescribed time period (usually three rings).

call forwarding, all calls Allows a station user to program a phone at any time to any internal station or the attendant. When activated by the station user, all calls—both internal and external—will be automatically rerouted to this preprogrammed number.

call forwarding, station busy Automatically reroutes incoming calls directly to a predetermined station or the attendant when the called station is busy.

call hold While conversing on any call in progress, the station user normally activates this feature either by first flashing the switchhook and then dialing the appropriate "hold" code or by depressing one of the feature buttons on the instrument.

call park Similar to the "call hold" feature and normally used in one of two ways: (1) an established call is placed in "park" condition

by dialing the access code and then transferring the call to another number where it goes without ringing. The phone is simply answered from the new location; or (2) a call is placed on "hold" and then retrieved from any other phone by dialing an access code and the telephone number of the phone holding the call.

call pickup Allows a phone user whose phone is part of a preprogrammed group to answer another ringing phone within that group by simply dialing an access code to seize the call.

call transfer Allows all calls that come into any given station whether from within or without the system to be transferred to any other line in the system. To transfer a call, a user flashes the switchhook once, dials the desired station, announces the call, and hangs up.

call waiting Allows a station user to hear a tone whenever a second call is attempting to contact that station. Upon hearing the tone, the station user can connect with the second call by flashing the switchhook and dialing an access code. The station user can then go back and forth between the calls by repeating the procedure.

camp-on Allows holding of a call on a busy line terminal until the line becomes idle, and then passes the call through automatically.

Carterfone A trademarked, acoustically-coupled device intended to couple a two-way radio circuit with local or long distance telephone facilities. The "Carterfone decision," in which the U.S. Federal Communications Commission permitted interconnection of the device, opened up the telephone terminal equipment market by permitting subscribers to buy or lease such equipment from firms other than telephone companies.

central office Facility housing the telephone switching system and related equipment for providing telephone service to customers in the immediate geographical area.

central processing unit (CPU) Core of the computer, containing the logic, computation, and control circuits. Controls the interpretation and execution instructions and sometimes contains memory; performs calculations and processes data according to instructions specified in software.

Centrex Service providing a business telephone customer with direct inward dialing to phone extensions as well as direct outward dialing access to WATS and other cost-saving facilities. Numerous PBX-like features are available to the customer.

Centrex CO Site in the central office where the service-providing switch is located.

Centrex CU Site on the customer's premises where the switch is located.

circle hunting Lines or stations arranged or programmed in such a way so that calls to any number in the group will—upon encountering a busy line or station—progressively search through the remaining lines or stations at least once and establish a connection with the first available (nonbusy) line or station.

circuit, four-wire Circuit that uses electrically separate paths for the two directions of transmission.

circuit, two-wire Circuit in which information signals in both directions are carried by the same two-wire path.

Class 1 office Regional toll center; the highest-level toll office in the North American switching hierarchy (there are only 10 in the U.S. and 2 in Canada). Together they form the basic upper-level network for long distance traffic in North America.

Class 2 office Sectional toll center; the second-level toll office in North America (55 in the U.S. and 10 in Canada).

Class 3 office Primary outlet in the long distance switching hierarchy for North America.

Class 4c office Toll center in the long distance hierarchy for North America.

Class 4P office Toll point in the long distance hierarchy for North America.

Class 5 office End office; a local central office or exchange in the North American switching hierarchy.

clipping Deforming of speech signals by the cutting-off of initial or final syllables.

code, cable color Code that identifies cable pairs by color.

common carrier Company, such as a telephone or telegraph company, that furnishes public telecommunications facilities.

concentrator Switching system in which a large number of inlets are connected to a smaller number of outlets.

conference operation In a telephone system, that type of operation in which more than two stations can carry on a conversation.

crash Complete failure of a hardware device (usually the CPU) or a software system control program.

crossbar system Automatic switching system in which the selecting mechanisms are electromagnetically operated mechanical crossbar switches of vertical and horizontal paths.

cross-connect Connections between terminal blocks on the two sides of a distribution frame or between terminals on a terminal block.

crosstalk Where a signal is transmitted on one circuit or channel of a transmission system, creating an undesired effect on another circuit or channel.

data Any representation, such as characters or analog quantities, to which meaning is or might be assigned.

data set Device that converts the signals of a business machine to signals that are suitable for transmission over telecommunications circuits and vice versa. The Bell System name for modem.

dedicated circuit Circuit used for communicating only between two points.

digital Using digital or discrete signals; not a continuously variable analog-type signal.

digital voice transmission Transmission of analog voice signals that have been converted into digital signals.

direct distance dialing (DDD) Telephone service that allows a user to dial outside the user's local service area, without the aid of an operator.

direct inward dialing (DID) Incoming calls are directed to the desired PBX or Centrex extension automatically (the last four digits being the identifier for the desired extension), bypassing the PBX attendant.

direct outward dialing Any, all, or selected stations can call outside, bypassing the attendant.

directed call pickup Station user is able to answer calls ringing on any station within the communications system by dialing a unique answer code (access code plus the station number) of the particular station to be answered. An optional arrangement provides that if the call has already been answered by the called station, the station user who dials the answer code will be "added on" (in a conference) to the connection, and a burst of tone will be applied to alert the first and second parties of the third party's presence on the line.

distinctive ringing Provides two different types of station ringing for audible distinction between internal and outside calls coming in to the station user. In some systems, more than two ringing patterns may be provided to accommodate other special types of incoming calls, such as those associated with automatic call back or call forwarding.

distribution frame Structure with terminations for connecting the permanent wiring in such a manner that interconnection by cross-connection can be readily made.

electronic switching system Any switching system whose major components utilize semiconductor devices. This usually includes semi-electronic systems that have core-reed, cross-reed, or cross-bar matrices.

end office Class 5 office in the North American hierarchic routing plan; a switching center where subscriber's loops are terminated and where toll calls are switched through to called lines.

erlang The number of erlangs is the ratio of the time a facility is occupied (continuously or cumulatively) to the time that this facility is available for occupancy. Named after its inventor, Danish mathematician A.K. Erlang.

exchange Room or building equipped so that telephone lines terminating there may be interconnected as required. Equipment may include manual or automatic switching equipment.

exchange, private branch (PBX) Small local telephone office, either automatic or manually operated, serving extensions in a business complex and providing access to the public switched network.

executive busy override Preselected stations are provided with this facility via preprogrammed instructions in the common equipment. It enables users of those stations, upon encountering a busy signal, to dial a single digit or activate a feature button and gain access to the existing conversation. Some systems restrict the use of this feature to break-in only on internal-to-internal connections.

facilities General word describing elements of equipment that provide a service. Also used in reference to the operating or maintenance service features made available by a system.

FAX Shortened version of facsimile, referring to the service or the actual machines by which a copy of a document or picture may be transmitted over a transmission medium.

Federal Communications Commission (FCC) In the U.S., a board of seven commissioners, appointed by the President, with the power to regulate all interstate and foreign electrical communications systems originating in the U.S. This includes radio, television, telegraph, telephone, facsimile, and cable systems.

fiber optics (FO) Branch of optical technology concerned with the transmission of radiant power through fibers made of transparent materials such as glass, fused silica, or plastic. Communications applications of fiber optics employ flexible fibers.

foreign exchange service (FX) Provides local telephone service

from a central office that is located outside the subscribers' exchange area.

forwarding, call PBX feature where the station user can program his or her station to another station or the console attendant either after a predetermined number of rings or on the first ring.

frequency, voice For normal telephony purposes, the band 300 Hz to 3400 Hz is transmitted. This is called the commercial speech band.

full duplex Simultaneous communications in both directions between two points.

grade of service For central offices/telephone exchanges, the probability of a call being blocked (all trunks busy) during the busy hour because of insufficient equipment or trunks.

hertz Unit of frequency: one cycle per second.

holding time Total time that a circuit is busy.

identification on outward dialing, automatic (AIOD) Ability of some Centrex units to provide an itemized breakdown of charges for calls made by each telephone extension.

integrated system Telecommunications system that moves analog and digital traffic over the same switched network.

interconnect Where a customer-provided piece of equipment is connected to or has access to the public switched telephone network.

interface Process of interrelating two or more dissimilar circuits or systems. The definition includes the type, quantity, and function of the interconnecting circuits and the type and form of the signals to be interchanged via those circuits. Mechanical details of plugs, sockets, pin numbers, and other items may be included within the context of the definition.

inward wide-area telephone service (INWATS) A particular service offered by AT&T Communications to allow other telephone users to call a particular number (long distance) without incurring a charge. The charges are met by the called subscriber on a measured basis.

jack Device in which a plug is inserted in order to make electrical contacts.

jumper Semi-permanent cross-connection wire on a main or intermediate distribution frame or other cross-connecting point.

K In the computer world, K means two to the tenth, or 1,024 in ordinary decimal figures.

key system Local telephone system (in-house) in a small office complex or home providing immediate access to all users, who press one or two keys. All users have access to lines on the public network and may communicate with each other without an operator.

kilobit One thousand bits.

light-emitting diode (LED) A pin-junction semiconductor device that emits optical radiation when biased in a forward directon, as a result of a recombination device. This is very often used in fiber optics where long life of the light-producing element is required.

Long Lines (LL) Department The AT&T department responsible for the operation of interstate toll services.

loop, local Line connecting subscribers' instruments or PBX to the local central office (CO).

line hunting Lines arranged or programmed in such a way so that a call incoming to that group, upon encountering a busy line, will progressively search through the remaining lines in that group and establish a connection to the first available (nonbusy) line.

matrix A simple switching network in which a specified inlet (matrix row) has access to a specified outlet (matrix column) via a crosspoint placed at an intersection of the row and column in question. Synonyms: connecting matrix, switching matrix.

megabit One million binary digits.

message center Portion of the communications center responsible for acceptance and processing of outgoing messages and for receipt and delivery of incoming messages.

mileage Distance used in tariff calculations. It is locally defined and usually refers to airline distance, rather than actual route miles.

modem Acronym for modulator-demodulator. A device that modulates and demodulates signals. Modems are used primarily for converting digital signals into analog signals for transmission over the voice-grade public switched network to another location to be converted back to a digital signal for computer processing.

modular In switching equipment, designed and manufactured in functional modules so that individual modules can later be replaced by updated versions (upgrades).

multiplex (MUX) (1) Use of a common channel to make two or more channels. This is done by splitting the common channel frequency band into narrower bands, each of which is used to constitute a distinct channel (frequency-division multiplex), or by allotting this common channel to multiple users in turn, to constitute different intermittent channels (time-division multiplex). (2) In telegraphy, simultaneous transmission of two or more messages in the same or opposite directions, using the same transmission path.

nano second One-billionth of a second.

network Organization of stations capable of intercommunication, but not necessarily on the same channel.

nonsynchronous data transmission channel Data channel in which no separate timing information is transferred between the data terminal equipment and the data circuit-terminating equipment.

office, central A 10,000-line switching center.

off-premises extension PBX extension located in a building that is connected to the PBX through public network cable-pairs.

on-hook (1) In telephone operation, the conditions existing when the receiver or handset is resting on the switch. (2) Idle state (open loop) of a subscriber or PBX line loop.

optical fiber Any fiber, made of dielectric material, that guides light. One of its uses is the transmission of signals.

outside plant That portion of intrabase communications systems extending from the main distribution frame outward to the telephone instrument or to the terminal connections for other technical components.

packet (1) A collection of data and control characters in a specified format, which is transferred as a whole. (2) Group of binary digits, including data and call control signals (computer commands), which is switched as a composite whole. The data, control signals, and error control information are arranged in a specific format.

packet switching (1) Describing a system whereby messages are broken down into smaller units called packets, which are then individually addressed and routed through the network. (2) Process of routing and transferring data by means of addressed packets so that a channel is occupied only during the transmission of the packet. Upon completion of the transmission, the channel becomes available for the transfer of other traffic.

pair The two wires of a circuit, particularly those providing the subscriber's loop.

patch To connect circuits temporarily by means of a cable known as a patch cord.

peg count A count of the seizure, or attempts at seizure, of telephone trunks, circuits, or switching equipment or of calls handled by an operator during a specified time interval.

pen register Moving-paper recording device used for checking dial pulse speed and ratio.

permissive connection Connection to privately owned facilities that is permitted by the telephone company but that is not guaranteed by the telephone company to perform satisfactorily in all respects.

Poisson tables Tables based on mathematical probabilities. They can be used to calculate the number of circuits needed in a group to achieve a specified grade of service for a given level of traffic.

practices Set of standard instructions that describe work procedures and are issued by major telephone organizations.

press-to-talk Type of handset with a button to activate the transmitter (increase the volume) in areas where there is a high noise level making it difficult to hear the incoming voice signal.

pre-wiring Practice of laying telephone cabling within a building during its construction.

program Instructions placed in the memory of a stored program-controlled switching system.

pulse code modulation (PCM) That form of modulation in which the modulating signal is sampled and the sample quantized and coded so that each element of information consists of different kinds or numbers of pulses and spaces.

quad Group of four wires composed of two pairs twisted together.

queuing Holding of calls in order of their arrival and presenting them automatically, in the same order, to an operator or to a trunk facility for its attention.

queuing theory Probability theory as applied to the study of delays.

raceway Covered conduit or channel for internal wiring and cabling.

rack, cable Light steel runway or ladder on which internal cables are laid in a central office and sometimes in private exchanges.

random access memory (RAM) Semiconductor chips within the computer in the telephone system. The CPU enters and retrieves information from RAM almost instantaneously.

read-only memory (ROM) If RAM is like a scratch pad, then ROM is like a printed book whose pages cannot be erased. Software to operate a telephone system is often stored in ROM.

real time Expression used in discussing the type of computer operation in which the computer is interacting with events in the world of people, rather than circuits. Generally, the interaction must take place

quickly enough to influence or react to the particular "people" event in progress.

relay Device (usually electromagnetic) by which current flowing in one circuit causes contacts to operate that control the flow of currents in other circuits.

repeater Device that amplifies an input signal or—in the case of pulses—amplifies, reshapes, retimes, or performs a combination of any of these functions on an input signal for retransmission.

ringdown Circuit on which the signaling is manually applied.

ring wire Second line wire (tip, ring, sleeve) of a telephone line, inside the office.

rotary dial Common telephone calling device that makes and breaks the loop provided by the instrument, thus transmitting the digits of the called telephone customer's number to the central office or exchange.

run, cable Route followed by cables, either directly buried or in ducts.

run, conduit Route followed by cable conduits. Also called a duct run.

sampling Process of taking samples, usually at equal time intervals.

sheath Outer covering of a cable. Its purpose is to provide protection for the insulated cable pairs housed within.

shield, cable Metallic layer around a cable core designed to minimize interference from external sources.

shielded pair Pair of conductors (in a cable) wrapped with metallic foil or braided to insulate the pair from interference.

signal Information that is transferred over a communications system by electrical or optical means. Also, a type of message, the text of which consists of one or more letters, words, characters, signal flags,

visual displays, or special sounds with prearranged meanings, and which is conveyed or transmitted by visual, acoustical, or electrical means.

solid-state circuit Integrated circuit with all the elements formed as a single block of semiconductor material.

solid-state memory Memory unit formed in a semiconductor chip.

speed dialing Allows a station user to assign abbreviated codes to certain frequently called numbers, usually associated with outgoing central office calls. This allows the user to dial selected numbers using fewer digits (one, two, or three, depending on the central PBX repertory) than normally required.

station message detail recorder (SMDR) Provides a record of the PBX station (or attendant) identity, starting time, duration, and the trunk group used for outgoing and/or incoming calls. The call duration is measured from about 10 seconds after the establishment of the connection in the customer's system to the time when the station goes on hook. Hence, busy signal, don't answer, and wrong number calls may also be recorded. A station-dialed account code may be recorded in addition to the calling station number.

station message detail recording Provides a record of the calling station or attendant number, starting time, call duration, all digits of the called number, and the specific trunk or trunk group used for outgoing calls. In almost all cases, these data are captured on magnetic tape or disk for future processing and pricing of calls. This information can be valuable in calling-area analysis and charge-back for telecommunications costs.

switch Mechanical or solid-state device that opens or closes circuits, changes operating parameters, or selects paths or circuits, either on a space- or time-division basis.

switch, analog See analog switch.

switch, digital Solid-state switch that switches digital signals by means of a time-division matrix.

switch matrix In a space-division exchange, an array of crosspoints that operates as a switch from a traffic point of view.

tariff Document filed by a communications carrier with a state Public Utilities Commission or the Federal Communications Commission (FCC) detailing services and equipment offered along with rate, pricing, and service prohibition information.

T-carrier General designation of any Bell digital transmission system.

telecommunication Any process that enables a correspondent to relay written or printed matter, fixed or moving pictures, words, music, or visible or audible signals or signals controlling the functioning of mechanisms, etc.; communication at a distance.

teleconference Conference between persons linked by a telecommunications system.

terminal (1) Device attached to the end of a wire or cable or to an electrical apparatus for convenience in making connections. (2) Input/output device connected to a processor or computer to enable communication with it and to control processing.

terminate (1) To connect a line to a terminal or equipment. (2) To connect a bridge across a circuit in order to make it stable.

tie line Trunk between PBXs. A tie trunk.

tie trunk Telephone circuit linking two private branch exchanges (PBX).

time sharing Method whereby facilities (usually computers) are shared by several users at the same time. The processor actually services the different users in sequence, but its high speed of operation in effect allows all to be serviced simultaneously.

time slot In switching, an interval in the time domain capable of providing a channel.

tip One of the two speech wires in a central office, the other being called a ring.

toll Charge for a long distance telephone call.

toll center (TC) Class 4C toll office where operators give assistance in completing incoming calls in addition to providing other traffic-related telephone functions.

toll center office Central office whose main function is the supervision and completion of toll calls.

traffic Messages sent and received that are tracked and measured for the engineering of circuit quantities and switching and routing patterns to maximize efficiency.

trunk Telephone communication path, or channel, between two points, one of them usually being a telephone company central office, or switching center.

trunk group Group of trunks between the same two geographical points, with similar characteristics, used for the same purposes.

twisted pair Pair of insulated wires that are twisted together but are not covered with an outer sheath.

user Person, group of persons, or organization that employs the services of a telecommunications system for the transfer of information to others.

voice-grade wire Wire suitable for transmitting a voice signal (300 Hz to 3400 Hz).

wide-area telecommunications service (WATS) Long distance service provided by AT&T Communications that allows calling to service areas at a discounted, prorated rate. Service areas are in one direction only, incoming or outgoing, but not both.

wideband Passing or processing a wide range of frequencies.

Acronyms and Abbreviations

ACD automatic call distributor
AMA automatic message accounting
ARS automatic route selection
ATB all trunks busy
ATE automatic test equipment

BOS bell operating system
BTC basic termination charge

CAS centralized attendant service
CBX computerized branch exchange
CCP cross-connection point
CCS 100 call seconds
CDR call detail recording (AMA, SMDR)
CO central office
COAM customer-owned-and-maintained equipment
COS class of service
CPE customer-provided equipment
CRT cathode ray tube
CTXCO Centrex central office

DDD direct distance dialing
DID direct inward dialing (bypassing PBX attendant)

ESS electronic switching system

FOTS fiber optics transmission system
FPY failures per year
FX foreign exchange (type of CO trunk)

Hz hertz (frequency, or cycles per second)

INC incoming trunk
INWATS inward wide-area telephone service

KTS key telephone system
KTU key telephone unit

LATAs local access and transport areas
LED light-emitting diode

MTS mobile telephone service
M/W microwave

NNX one form of office code where N is any digit 2-9 and X is any digit
NPA numbering plan area
NXX newer form of office code

OCC other charges or credits (on phone bill)
ONI operator number identification
OPS off-premises station (formerly OPX or off-premises extension)

PAM pulse amplitude modulation
PBX private branch exchange
PCB printed circuit board
PCM pulse code modulation
PMBX private manual branch exchange
PROM programmable read-only memory

Q queue

RAM random access memory
ROM read-only memory (can be random access)
RSU remote switching unit
RS 232 a digital interface standard

SMDA station message detail accounting
SMDR station message detail recording (AMA, CDR)
SSTV slow-scan television
TDM time-division multiplexing
TFC traffic
TL tie line
TSPS traffic service position system

USOC uniform service order code

VDU video display unit
VG voice grade
VIDEOTEX interactive computer-controlled system using TV and phone

WATS wide-area telecommunications service

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CAMPUS TELEPHONE SYSTEMS

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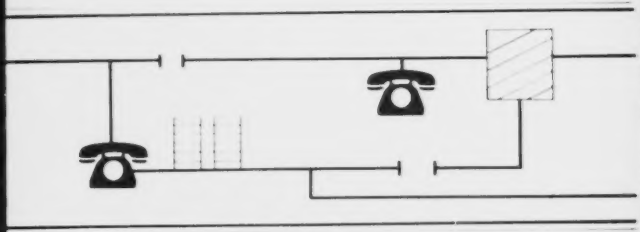

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Telephone deregulation and the divestiture of AT&T have signaled unprecedented growth in the telecommunications market. A wide range of choices in telephone equipment and long distance services, new management information systems, and revolutionary technological changes present new challenges and opportunities to campus administrators. *Now, more than ever, effective campus management is crucial when selecting a cost-effective campus telephone system.*

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